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EDITORIAL

As this is the first number of "The Agricultural Journal of India" to appear under the auspices of the Imperial Council of Agricultural Research, a few words of explanation as to the aims and objects of the Council may not be unwelcome to those readers who are not yet acquainted with its activities. The conditions which prevail to-day are radically different from those in 1906 when the Journal began its career. With the advent of the Reforms in 1920, the direction of agricultural and veterinary activities passed from the Central Government to the provinces. The former, however, retained its responsibility for the promotion of research of all-India importance as well as control over the research institutions at Pusa and Muktesar, and it still continues to develop them within the limit of its means. The need for some co-ordination of effort soon, however, began to be felt, but it was left to the Royal Commission on Agriculture which recommended the formation of a Central Council of Agricultural Research to discover a way out of the difficulty. In addition to representatives of the Central Legislature and of the commercial community, the Council of Agricultural Research has on its Governing Body the Ministers of Agriculture of all the provinces and on its Advisory Board the heads of all the Agricultural and Veterinary Departments in the provinces. Its constitution provides further for the representation of Universities as well as of Indian States one of whom, Hyderabad, has already decided to take advantage of the opportunity offered. In this manner, the Government of India, who also are represented both on the Governing Body and the Advisory Board of the Council, as well as Provincial Governments share equally in the direction of the Council's activities. The Council is not an organization superimposed on existing Imperial and Provincial Agricultural and Veterinary Departments, but one to which, it is expected, they will all bring their problems for discussion and for help in their solution. The central co-ordinating agency which was lacking before has thus been provided.

The aim of the Council is not merely to proffer advice but by means of grants-in-aid, where such are necessary, to provide the means of rendering such advice fruitful. Interference in the slightest degree with the Imperial and Provincial Departments concerned would neither be tolerated nor is it intended. On the other hand, the funds of the Council should not be utilized to relieve those departments of expenditure which can be held normally to fall to their share. There are, however, lines of work which may, if undertaken, advance the prosperity of Indian agriculture generally but which do not fall wholly within the ambit of any one department's activities and which were hitherto either postponed or not undertaken at all because there was more urgent work which needed financing.

The results of agricultural and veterinary research conducted in India are at the present moment not easily available for the information either of the scientific

enquirer or of the layman in India or abroad. It is the same in regard to the results of research carried on outside India. By establishing direct relations with imperial and international scientific bodies connected with agricultural and veterinary advancement, by taking over the work of issuing agricultural publications hitherto conducted from Pusa by the Agricultural Adviser to the Government of India, and by helping the publication of the results of private scientific work in India in the domain of agriculture, it is the aim of the Council to be not only a storehouse of information but also its purveyor to all such as may be interested therein. It is hoped that in course of time a publication issuing under the ægis of the Council will not only receive the widest possible publicity but will also be regarded as of high scientific merit.

The Council's main objective is the promotion of research but this phrase may be variously construed. The close link between central and provincial institutions will enable that "fundamental", "long range" and "wide range" research—to use the catchwords of the day—will all receive their share of attention, and that the immediate needs of every day agriculture in India will keep their proper place in the picture. Whilst laying sound foundations for the future, the Council may be trusted to so administer its funds that all the links in the chain of application of science to agricultural practice are properly forged. His Excellency the Viceroy, in concluding his address at the inaugural meeting of the Council, said that the Council has a great opportunity to improve India's staple industry; he uttered the prayer that its achievement may equal its opportunity; the Council, by its endeavours, must fulfil it. This number of "The Agricultural Journal of India" is the formal token of the Council's intention to aid in the dissemination of agricultural information. For the material which it contains the principal credit is due to the previous editor, the Agricultural Adviser to the Government of India, and to the individual contributors. The new editors trust that they may rely on that cordial support from many contributors which has won for the Journal its present position in agricultural literature. It will be their constant aim not merely to maintain but to improve on the high standard set by their predecessors.

ORIGINAL ARTICLES

CROP ROTATION EXPERIMENTS AT THE LYALLPUR FARM.

BY

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THE problems connected with the effects of different rotations on the fertility of the soil are everywhere very important; but they are especially so in the Punjab Canal Colonies. For here two very different classes of crops are regularly grown; tropical crops in the summer season and the crops of temperate climates in the winter. Perennial irrigation allows of great variation in the proportions and combinations of these crops. For instance, on the average the canal lands are cropped about once a year but many fields produce three crops in two years and sometimes even four. The intensity of cropping practised affects the yield of each crop very greatly and is intimately connected with every problem in farming practice. It directly affects such matters as the best amount of water to apply, the result from manurings, the returns from good cultivation and the prevalence of weeds. The amount of water, the amount of manure, or the number of cultivations which it is best to give under one system of cultivation will not necessarily be the best if the same land be more or less intensively cropped. The maximum intensity which is possible naturally depends upon the water supply. But even with a fixed supply there is room for considerable variation; for a large area of crops demanding little water, or a small area of crops demanding much water may be grown; or a part of the land may be more heavily cropped than the remainder, or a medium intensity may be adopted throughout. The experimental study of the economics of different rotations of crops is rendered much more difficult by this relationship with the water supply and it has not yet been taken up on the scale which it merits. A beginning has, however, been made which has yielded some very interesting results which I have endeavoured to set forth below.

In 1920, the then Professor of Agriculture, Mr. Roberts, organized a series of experiments designed to throw some light on the subject. An area of land in Square No. 26 containing 12 acres was selected as suitable for the purpose. Prior to 1920, this block was cropped for eight years on a rotation of wheat-wheat-*toria*-cotton, when the lay-out was exactly the same as it is now. The yields obtained from this cropping have shown that the fields are very comparable in the way in which they are arranged though there is a difference in fertility of the order of 15 or 20 per cent. in the two sides, *i.e.*, from S. E. to N. W. (Fig. 1.) The yields for the eight

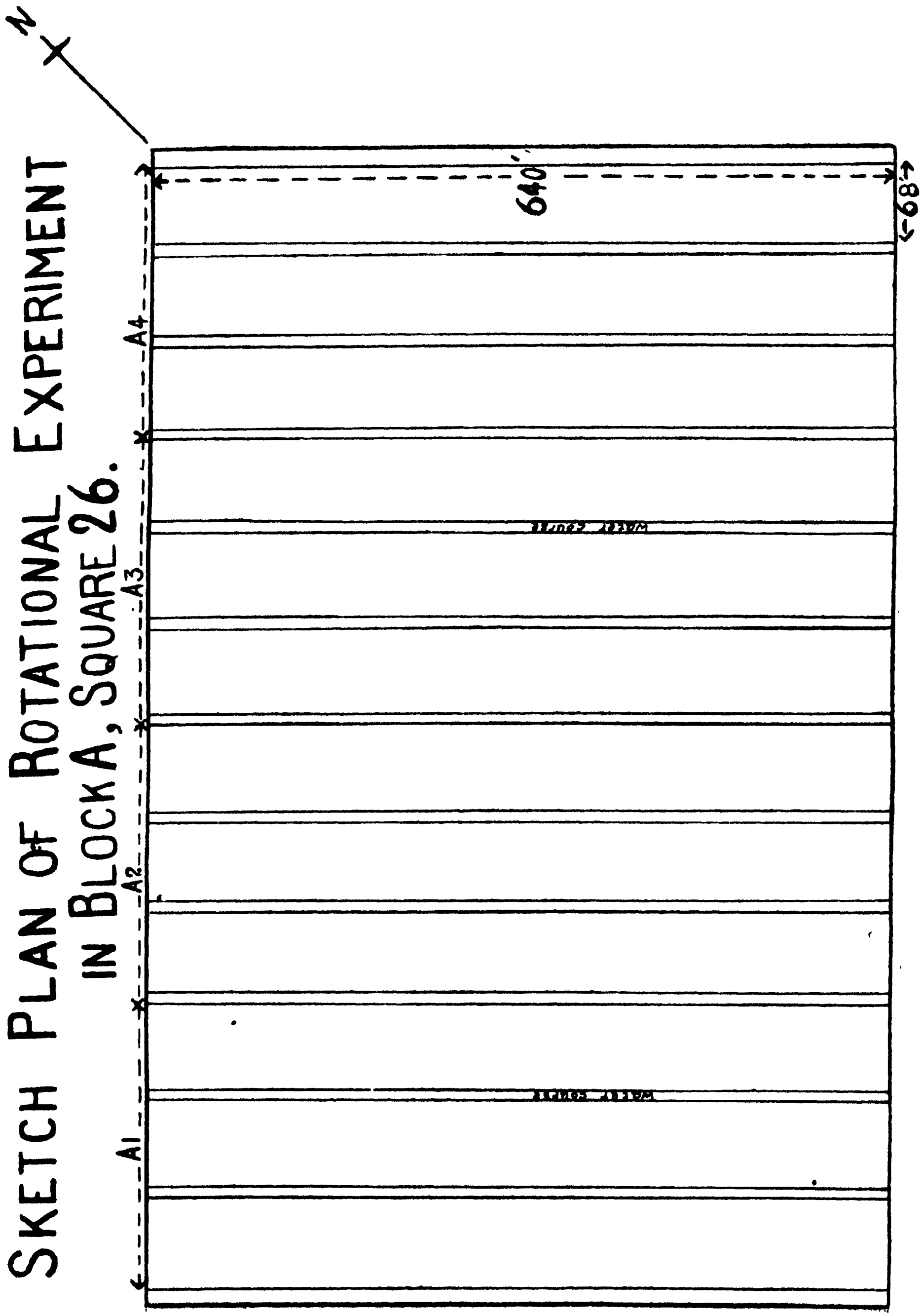
SKETCH PLAN OF ROTATIONAL EXPERIMENT
IN BLOCK A, SQUARE 26.
N
640'
68'
A4
A3
A2
A1

FIG. 1.

years are given in Table I. To judge from the yields of wheat and *toria* there is little sign of any reduction in fertility. But the yields of cotton were very poor in the later years. In this connection it may be noted that cotton here follows *toria* after a few weeks' interval only, whereas the other crops follow summer fallows.

Another point of interest is that where wheat has followed cotton the yields obtained have been, on the average, 30 per cent. higher than where wheat has followed wheat.

No manure was applied to the land, two summer fallows in each complete rotation being depended upon for restoring soil fertility.

In 1920, as previously stated, the existing rotation was dropped and the land put under four other rotations of different intensities. These rotations are such that they make very different demands on the water supply and on the fertility of the soil. Each block under a rotation consists of three fields as shown in the sketch plan appended. The rotations are all three-year rotations and are given below :—

Block A. 1.

First year	Summer	Fallow.
	Winter	Wheat (*Triticum sativum*).
Second year	Summer	Fallow.
	Winter	Fallow.
Third year	Summer	Cotton (*Gossypium hirsutum*).
	Winter	Cotton.

This rotation gives an intensity of 66 per cent., *i.e.*, two crops in three years.

Block A. 2.

First year	Summer	Fallow.
	Winter	Wheat.
Second year	Summer	Fallow.
	Winter	Gram (*Cicer arietinum*).
Third year	Summer	Cotton.
	Winter	Cotton.

This rotation gives an intensity of 100 per cent., *i.e.*, three crops in three years, and differs from that previously followed in that cotton follows a leguminous crop, gram, instead of a fallow.

Block A. 3.

First year	Summer	. . . .	*Guar* (*Cyamopsis psoraloides*) grown and ploughed in for green manure.
	Winter	. . . .	Wheat.
Second year	Summer	. . . .	Fallow.
	Winter	. . . .	*Toria* (*Brassica campestris*).
Third year	Summer	. . . .	Cotton.
	Winter	. . . .	Cotton.

This rotation gives an intensity of 133 per cent., *i.e.*, four crops in three years, including the green-manuring crop. Cotton here follows *toria* and the land is green-manured once in three years.

Block A. 4.

First year	Summer	. . . .	Fallow.
	Winter	. . . .	Wheat.
Second year	Summer	. . . .	*Chari* (*Andropogon Sorghum*) and *Guar* grown mixed for fodder.
	Winter	. . . .	Gram.
Third year	Summer	. . . .	Cotton (Receives farmyard manure at the rate of 10 tons per acre).
	Winter	. . . .	*Senji* (*Melilotus parviflora*) for fodder.

This rotation gives an intensity of 166 per cent., *i.e.*, five crops in three years. The quantity of manure applied roughly corresponds to the amount resulting from feeding the two fodder crops to cattle.

The appended sketch plan shows the lay-out of the land and the dimensions of the plots, each of which is one acre in extent.

The effects of the various rotations are here compared from three main aspects, *viz.*—

(*a*) Comparative outturns obtained.
(*b*) Effects on soil fertility.
(*c*) Net financial returns obtained.

Table II shows the comparative outturns obtained from the different crops grown in each rotation. Each crop has been dealt with separately as regards yields and effects on soil fertility; then all *in toto* as regards financial returns obtained.

WHEAT.

As this crop is less liable to seasonal variations than most of the others grown, the yields obtained should more truly indicate improvements in soil fertility. I shall therefore deal with it first.

In the first cycle of three years from 1920 to 1922 there is not much difference between the yields obtained under the different intensities. Up to this time only

one crop of wheat had been taken from each field. In blocks 1, 2 and 4, the wheat followed a fallow, whereas in block 3, where the highest yield was obtained, it followed *guar*, a leguminous crop which had been ploughed down as green manure.

In the second cycle, 1923 to 1925, the yields have increased with the intensity of cropping, the averages ranging from 26·93 maunds in the lowest to 32·64 maunds per acre in the highest rotation. The average increase in yield obtained from all blocks in this cycle is 49 per cent. higher than that obtained in the first cycle, so either the land must have improved or the seasons were more favourable.

In the third cycle, the yields have again increased with the intensity of cropping but the average of all has fallen by about 4 per cent. below those of the second cycle. The chief reason for this is that there was a partial failure of the crop in 1927-28. This failure reduced yields all over the farm by about 20 per cent.

Fig. 2—ignoring the seasonal fluctuations—shows that the general trend of the yields has been upwards throughout the nine years of the trial; also that the increase in yield has been greater in the more intensive rotations. As the same plots were under wheat for four years in the previous rotation, the averages of those yields have been used as the starting point for each graph. A further glance at the graphs shows that the A-4 rotation which started off with the lowest yield finished up with the highest. The average yields obtained from all rotations in the last cycle are 43·5 per cent. higher than the average yields obtained from all rotations in the first cycle.

The results indicate, generally, that there has been a gradual improvement in the fertility of the soil in all rotations, and again that a greater increase of fertility has been effected in the rotations of higher intensity than in those of lower intensity.

COTTON.

Owing to the fact that this crop is much more subject to seasonal variations than wheat, it is difficult to estimate the degree of improvement, if any, which has been effected in yields. Fig. 3 shows that yields have varied from nothing in one season to almost 17 maunds per acre in another. On making an average of the yields obtained in each rotation throughout the whole period, it was found that there was a difference of less than one maund between them; from these results it cannot therefore be said that one rotation is better than another.

Again looking at the results from the point of view of improvement in the general fertility of the soil from one cycle to another, nothing definite can be said, as the crop was almost a failure the first year and a complete failure the second year of the experiment due to unfavourable seasons; and during the other years the yields fluctuated so widely that no inference is possible.

Prior to laying down this experiment, as previously noted, this land was cropped for eight years on a rotation of wheat-wheat-*toria*-cotton. The cotton grown then was the same variety as is grown in the present series, *viz.*, 4 F. American. The

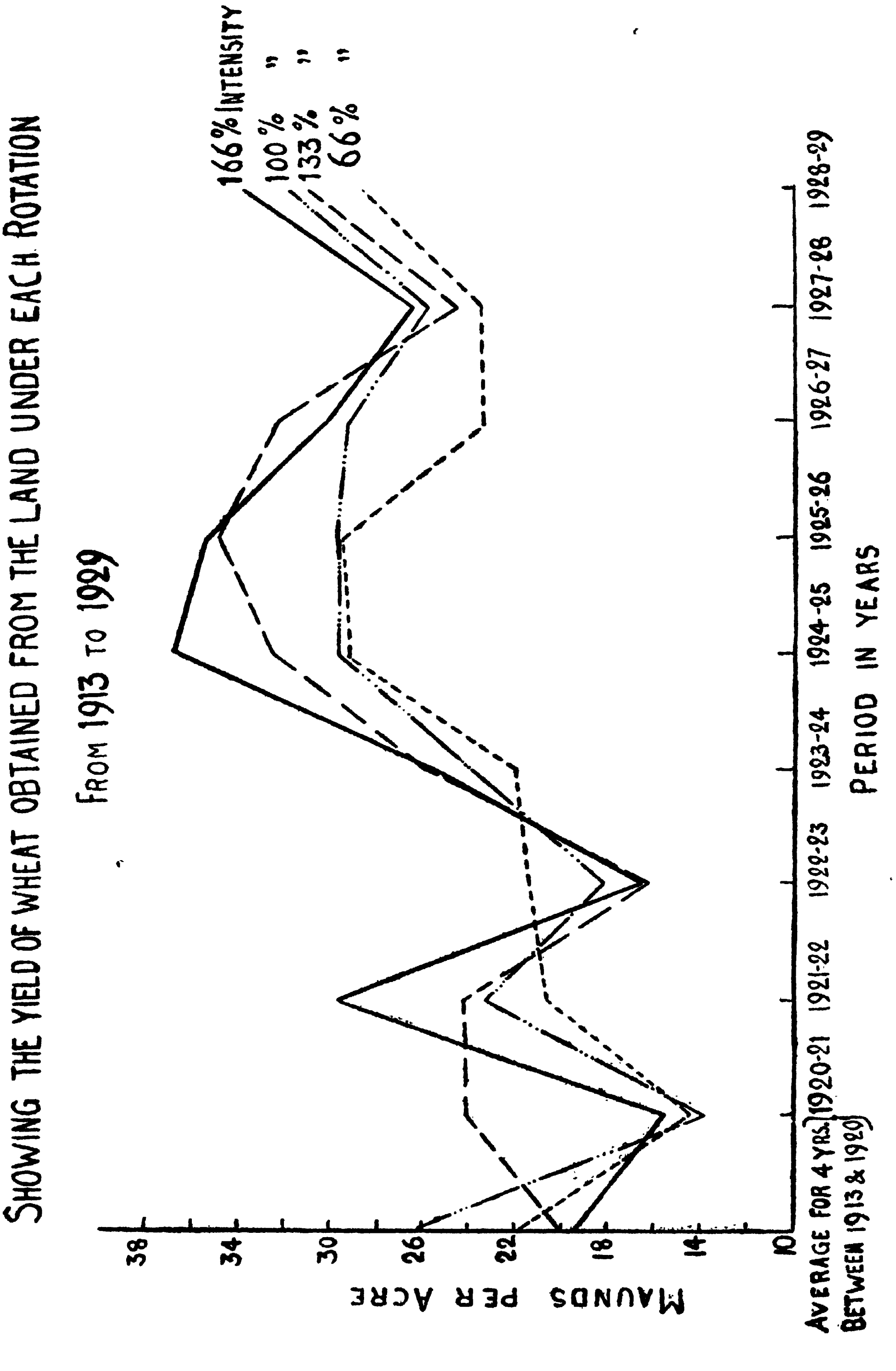
SHOWING THE YIELD OF WHEAT OBTAINED FROM THE LAND UNDER EACH ROTATION
FROM 1913 TO 1929
166% INTENSITY
100% "
133% "
66% "
MAUNDS PER ACRE
38
34
30
26
22
18
14
10
AVERAGE FOR 4 YRS. BETWEEN 1913 & 1920
1920-21
1921-22
1922-23
1923-24
1924-25
1925-26
1926-27
1927-28
1928-29
PERIOD IN YEARS

FIG. 2.

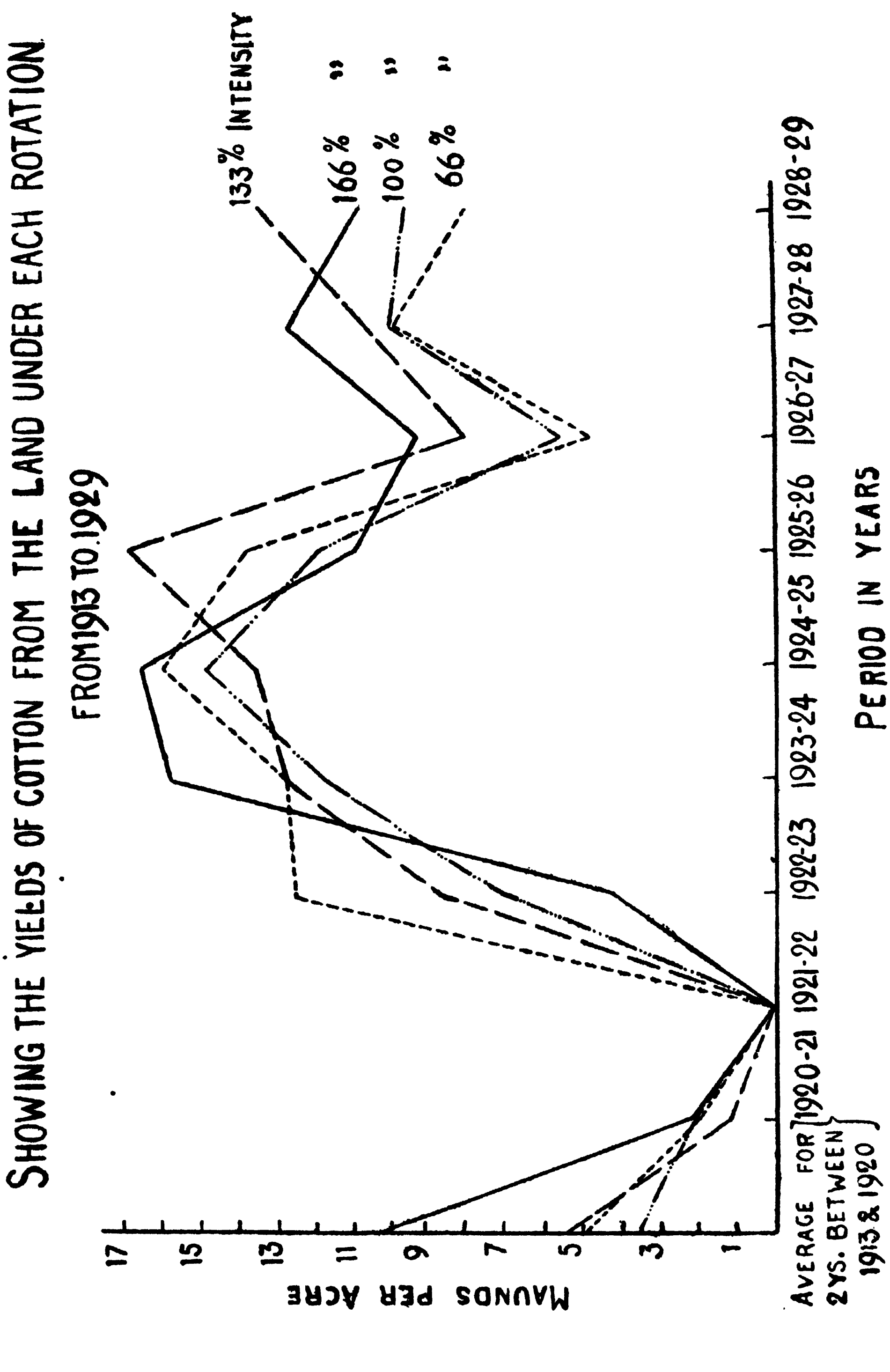
SHOWING THE YIELDS OF COTTON FROM THE LAND UNDER EACH ROTATION
FROM 1913 TO 1929
133% INTENSITY
166% "
100% "
66% "
MAUNDS PER ACRE
17
15
13
11
9
7
5
3
1
AVERAGE FOR 2 YS. BETWEEN 1913 & 1920
1920-21
1921-22
1922-23
1923-24
1924-25
1925-26
1926-27
1927-28
1928-29
PERIOD IN YEARS

Fig. 3.

average annual yield, per acre, obtained from the whole block during the present nine-year period, including the years of failure (1920 and 1921), was 9·5 maunds per acre, whereas the average annual yield obtained in the previous eight years was only 6·13 maunds per acre. This increase of 54 per cent. in the latter period seems to indicate that a very important improvement has taken place in the fertility of the block as a whole since these rotations were laid down.

TORIA.

This crop is only grown in one block, *viz.*, in the 133 per cent. rotation, so yields from other rotations in this case are not available for comparison. But on comparing the yields obtained from one cycle to another, we find that they have fallen (Table II), the most noticeable fall having taken place in the last cycle. This, however, was chiefly caused by a partial failure of the crop in 1928-29.

Prior to laying down this rotation, however, *toria* was grown in the same block in 1914-15 and again in 1918-19, the average yield for these two seasons being 8·23 maunds per acre per annum as compared with an average of 12·87 maunds per acre per annum for the last nine years. It would, therefore, also appear from these figures that the land has considerably improved in fertility since the present rotations were laid down.

GRAM.

This crop is only grown in the second (100 per cent.) and fourth (166 per cent.) rotations. Throughout the period of the experiment it has given higher yields in the second rotation, *viz.*, 22·56 maunds per acre on the average, as against 18·43 maunds per acre for the fourth rotation (Table II). These differences in yield may be accounted for by the fact that the crop in the second rotation follows a summer fallow, whereas the crop in the fourth rotation follows immediately after a fodder crop, the land having very little time in which to recuperate.

Yields generally have increased from one cycle to another in each rotation, those in the third cycle being on an average 24 per cent. higher than those in the first cycle; again an indication of an improvement in the fertility of the soil.

SENJI.

This crop is only grown in the fourth rotation (166 per cent.). It is a leguminous fodder which is supposed to improve the fertility of the soil. The annual yields obtained show wide fluctuations but the general trend is downwards right from the commencement of the experiment. The average outturn obtained in the first cycle of three years was 209·9 maunds per acre as against 150 maunds per acre in the last cycle. This crop is sown in the standing cotton before the latter is entirely harvested, so the land obtains no rest at all; this may account for the falling off in yields.

CHARI-GUAR.

These two crops are sown mixed in the fourth rotation (166 per cent.) and are intended for fodder purposes. The *guar* is a leguminous crop and may contribute something towards the maintenance of soil fertility.

The yields of fodders obtained have steadily fallen throughout the period. The average yield for the first cycle was 290·5 maunds per acre which fell to 273·1 maunds in the second cycle and 244·3 maunds in the third cycle. Here again these two mixed crops follow closely on the heels of another wheat—which may account for the diminishing yields.

Similar results have been obtained where gram follows a fodder crop in block A.4, the yields on the average being 18 per cent. below those of the plots in A.2, where the gram follows a fallow.

Yields do not appear to be depressed where the land receives a rest of two months or more. In block A.3, where wheat follows a green manure crop, there is no reduction, similarly where cotton follows *toria* in the same block there is no reduction.

FINANCIAL RESULTS.

The most important aspect of the experiment is the financial one. Does it pay to practise intensive cultivation continuously, or does it not, that is the problem we have now to consider.

In the conduct of the experiment a careful record has been kept of the actual cultivation expenses in each rotation block; comparative figures of income from each are thus available. These are given in Table III appended. Produce prices taken were those prevailing in Lyallpur Mandi at the time of each harvest. All labour was charged for at local rates.

Fig. 4 gives the comparative net income obtained from each three-acre block under the different rotations, from 1921 to 1929.

Wide fluctuations in the prices of produce during the period of the experiment have partially nullified the advantages gained from the increased yields obtained, particularly towards the end of the period. Prices of cotton were very high from 1923 to 1925 and yields at the same time were exceptionally good, so the peaks of all the graphs coincide with these years; thereafter they have dropped in sympathy with the prices of produce. A glance at Table III will make the position clearer. If we take the average net income of all rotations from cycle to cycle (leaving out the second which contains abnormal years for both prices and yields), there is an increase of Rs. 256 in the third cycle over that of the first cycle. This represents an increased net income of Rs. 7-2-0 per acre per annum, which is quite good considering that the cotton crop was much below normal in two of these years and the wheat crop about 20 per cent. below normal in one of them.

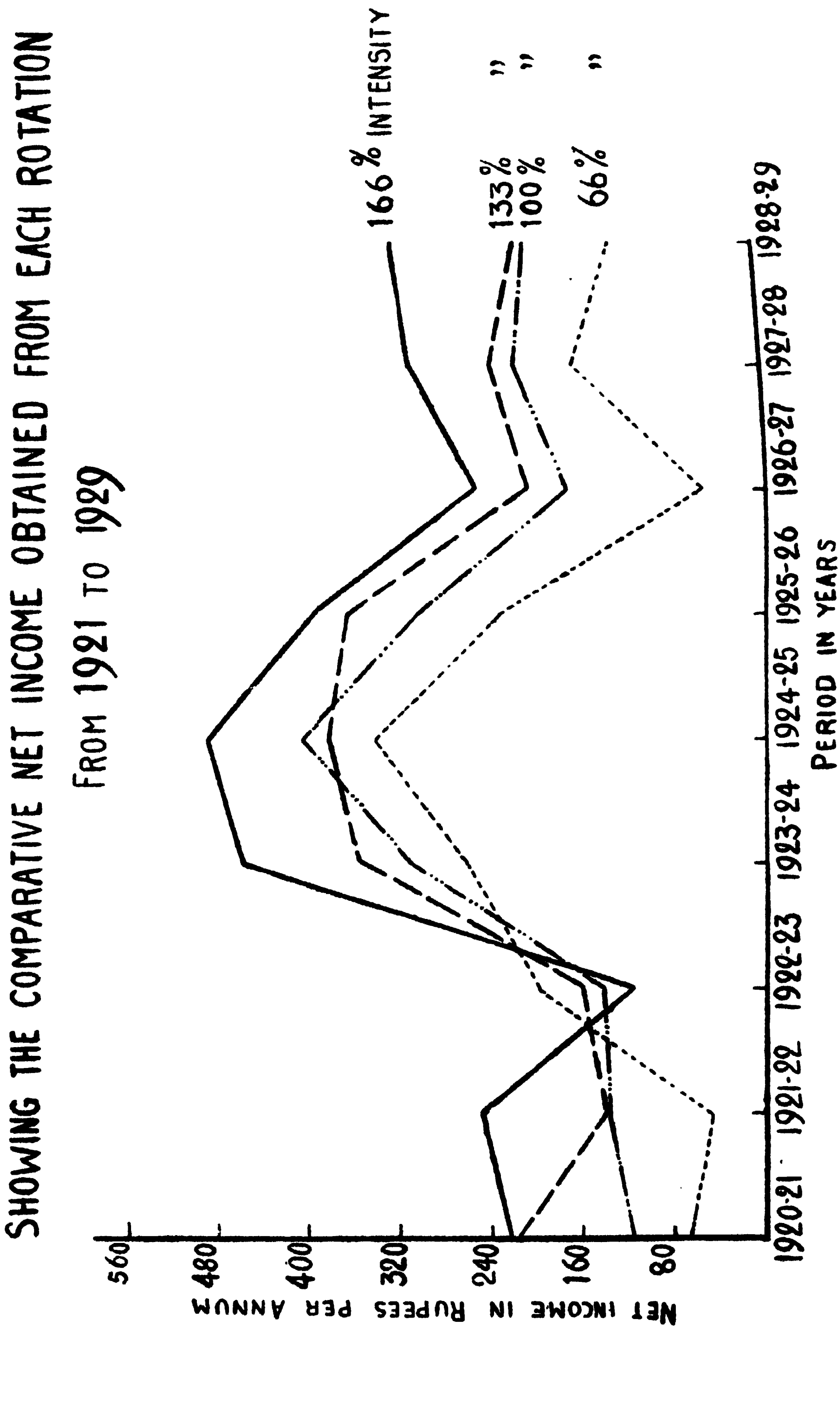
SHOWING THE COMPARATIVE NET INCOME OBTAINED FROM EACH ROTATION
FROM 1921 TO 1929
166 % INTENSITY
133 % "
100 % "
66 % "
NET INCOME IN RUPEES PER ANNUM
560
480
400
320
240
160
80
1920-21
1921-22
1922-23
1923-24
1924-25
1925-26
1926-27
1927-28
1928-29
PERIOD IN YEARS

Fig. 4.

Examining the figures in another way, from the point of view of intensity of cultivation we find that the net returns increase with the intensity of cultivation. The net income obtained from each rotation for the nine years was as follows :—

Rotation	Net income Rs.	A.	P.
66 per cent. intensity	1,540	11	8
100 " "	2,065	15	1
133 " "	2,314	12	8
166 " "	2,878	11	10

These figures leave no doubt as to the more intensive rotations being at present the most profitable.

The experiment is being continued as it would be unwise to assume from these results that the more intensive rotations will indefinitely give the highest returns.

Summary of conclusions.

1. Where wheat has followed cotton, the yields obtained have been, on the average, 30 per cent. higher than where wheat has followed wheat.
2. Yields obtained from the more important crops indicate an improvement in the soil fertility of the block as a whole since the present experiment was laid down.
3. There has been a gradual improvement in the fertility of the soil under all rotations since the present experiment was laid down.
4. The rotations of higher intensity have improved soil fertility more than those of lower intensity.
5. Any one of the rotations now practised is more suitable for the maintenance of soil fertility than the previous rotation—wheat-wheat-*toria*-cotton.
6. Where one crop follows another without the land being allowed a rest, the yields of such crop have consistently declined.
7. The net returns obtained from the land under the experiment have increased from the first to the third cycle and also with the intensity of cultivation.

TABLE I.

*Outturns obtained from different crops in Square 26, Block A, under the rotation—Wheat-Wheat-*Toria*-Cotton from 1913 to 1920.*

Sub-block	Crop	1912-13	1913-14	1914-15	1915-16	1916-17	1917-18	1918-19	1919-20
		Md.	Md.	Md.	Md.	Md.	Md.	Md.	Md.
A 1	Wheat after Cotton	..	..	20·77	..	..	..	24·52	..
A 2		..	..	..	26·45	..	..	..	35·21
A 3		26·21	..	..	..	23·62	..	..	..
A 4		..	19·19	..	..	..	22·66	..	..
A 1	Wheat after Wheat	..	..	..	21·04	..	..	..	20·99
A 2		23·03	..	..	..	20·47	..	..	..
A 3		..	15·76	..	..	..	15·37	..	..
A 4		..	..	18·60	..	..	..	17·21	..
A 1	*Toria*	11·9	..	..	..	13·81	..	..	..
A 2		..	12·57	..	..	..	11·46	..	..
A 3		..	..	5·64	..	..	..	10·83	..
A 4		..	..	..	8·86	..	..	..	9·42
A 1	Cotton	..	3·64	..	..	..	6·36	..	..
A 2		..	..	4·91	..	..	..	2·34	..
A 3		..	..	..	8·82	..	..	..	2·22
A 4		14·55	..	..	..	6·27	..	..	..

TABLE II.

Outturns obtained from the different crops grown in each rotation in Square 26, Block A, from 1920-21 to 1928-29.

Intensity of rotation	Sub-plot No.	Crop	YIELDS PER ACRE FROM 1920-21 TO 1928-29									Remarks
			1st Cycle			2nd Cycle			3rd Cycle			
			1920-21	1921-22	1922-23	1923-24	1924-25	1925-26	1926-27	1927-28	1928-29	
Per cent.			Md.	Md.	Md.	Md.	Md.	Md.	Md.	Md.	Md.	
66	A 1	Wheat	14·4	20·62	21·6	22·04	29·2	29·57	23·5	23·5	28·87	
100	A 2	Do.	13·95	23·15	18·3	23·98	29·7	29·85	29·43	25·92	32·02	The year 1920-21 was a very bad one for cotton, while in 1921-22 it was a total failure.
133	A 3	Do.	24·18	24·27	16·52	26·05	32·7	34·98	32·6	24·7	31·05	
166	A 4	Do.	15·6	29·8	16·55	25·72	36·75	35·45	30·2	26·74	34·15	
66	A 1	Cotton	2·08	Failure	12·5	12·74	16·0	13·72	4·78	9·9	9·12	The year 1926-27 was also bad for cotton and the price was very low. There was a partial failure of wheat in 1927-28.
100	A 2	Do.	2·15	Do.	7·1	11·57	14·93	11·82	5·5	10·0	9·62	
133	A 3	Do.	1·16	Do.	8·65	12·71	13·52	16·95	8·02	10·57	13·52	
166	A 4	Do.	2 4	Do.	4·33	15·8	16·6	11·08	10·5	12·8	10·85	
133	A 3	*Toria*	11·5	17·82	11·57	13·7	12·2	13·15	15·05	13·4	7·5	In 1928-29 the *Toria* crop was a partial failure.
100	A 2	Gram	14·98	21·35	18·0	26·08	25·7	29·55	26·23	22·08	19·1	
166	A 4	Do.	8·16	17·43	15·6	25·52	20·02	28·3	18·32	13·6	18·99	
166	A 4	*Senji*	256·0	254·1	119·7	151·1	200·0	198·0	150·0	160·0	140·0	
166	A 4	*Chari-Guar*	408·4	256·0	207·4	263·1	267·6	288·8	206·2	204·05	322·8	

TABLE III.

Financial returns obtained from the different rotations practised in Square 26, Block A, for nine years from 1920-21 to 1928-29.

Intensity of rotation	Block	1st Cycle 1920-21 to 1922-23			2nd Cycle 1923-24 to 1925-26			3rd Cycle 1926-27 to 1928-29		
		Gross income	Cost of cultivation	Net income	Gross income	Cost of cultivation	Net income	Gross income	Cost of cultivation	Net income
Per cent.		Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
66 .	A 1	658 5 6	345 5 0	313 0 6	1,301 15 6	445 8 0	856 8 0	781 15 2	410 12 0	371 3 2
100 .	A 2	827 1 0	422 3 0	404 14 0	1,546 15 2	505 9 0	1,041 6 0	1,133 7 1	513 12 0	619 11 1
133 .	A 3	963 2 2	456 15 0	506 3 2	1,700 8 5	576 3 0	1,124 5 0	1,242 3 8	557 15 0	684 4 8
166 .	A 4	1,160 8 5	564 3 0	596 5 5	2,052 11 1	684 0 0	1,368 11 1	1,576 6 4	662 11 0	913 11 4

NOTE 1. The net income is highest in the second cycle as there was no failure of any crop during that period. Prices of cotton were also very high at the same time.
2. The year 1926-27 was an exceptionally bad one for cotton, while prices also were very low.
3. There was a partial failure of wheat in 1927-28.

THE MANGO HOPPER PROBLEM IN SOUTH INDIA.*

BY

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INTRODUCTORY.

THE mango is a native of tropical and sub-tropical India, and the wild or semi-wild variety--known commonly as the "country mango"—is found growing naturally in the forests and jungles of South India, or planted as avenue or shade trees in many parts of the plains. Till comparatively recently, the more valuable varieties whose delicious and even luscious fruits have served to give the mango its world-wide reputation, were the monopoly of either the ruling chiefs or the big landlords. Indeed, if it had not been for the enlightened patronage of such people, the various superior varieties could not have been evolved and perpetuated.

The large scale commercial cultivation of the various valuable graft mangoes of South India is comparatively of recent growth. In the Madras Presidency, the development of such a cultivation is chiefly noticeable in the three following tracts—Vizagapatam, Chittoor and Salem; but there are indications to show that it is becoming more and more popular and spreading into other parts of the province. Whereas the older gardens are restricted mostly to locations having facilities for frequent irrigation, the more modern ones have been planted mostly on the dry system. In many places gardens have come into existence in fields which had been considered too poor to grow any crop. What the ryot has done in many cases is just to fence an area, dig pits, and plant the grafts, after providing just a little leaf-mould or manure to give them a start. They are watered and generally looked after carefully for about four or five years, after which they are usually left to themselves. The trees begin to yield in five or six years, and continue to yield fruits till they are 25 to 30 years old, after which in some areas steps are taken to replace them. Considering the fact that there is not much recurrent expenditure, when once the trees have begun to yield, this system may be considered fairly lucrative, and there is therefore a growing tendency for the extension of mango culture into areas suited to its cultivation.

REPORTS OF MANGO HOPPER DAMAGE.

Since the inception of the Agricultural Department in Madras, there have been, almost every year, several reports of damage to the mango crop by the hopper pest.

* Paper read in the Agricultural Section of the Indian Science Congress, held at Madras in January 1929.

However, though in some years the hopper was the real cause of the damage, it often proved to be but one of the many factors contributing to the loss of crop. In some cases the main factor resolved itself to be an abnormally heavy outbreak of mildew, and in others it was want of good setting due to adverse weather conditions, and sometimes it was a combination of all these acting in varying degrees of dominance.

The first attempt at spraying in this province was made in the year 1913 in the Chittoor District. In 1914 and 1915 spraying was demonstrated with a fair amount of success in Salem and Chittoor. In the season of 1916-17, a demonstration of spraying was undertaken in a mango garden at the Bhumanagadda Criminal Settlement near Madanapalli, and in 1917-18 another at the important mango centre of Alamanda in the Vizagapatam District, but apparently without conclusive results. After 1918 no further work was undertaken till December 1922, when, at the request of the Deputy Director, IV Circle, arrangements for demonstrating spraying were made in the Chittoor District. At about the same time a letter was received from the Deputy Director of Agriculture, I Circle, suggesting the advisability of undertaking further work in the Alamanda area for the purpose of working off the prejudice that had developed there against spraying. In the course of the spraying work in 1922-23, it became apparent that the want of success in some of the previous years was in reality due to the want of adequate knowledge not only of the hopper but also of the flowering and fruiting habits of the mango itself. The details of the life-history of the three species of hoppers were not known, nor was anything known as to their reactions to different environmental conditions. The reasons underlying the difference in response by the different varieties of mango to the self-same conditions had not been determined. The heavy fruit-fall that often transforms a satisfactorily set crop into a dismal failure was found not to have been taken into account in adjudging the results of spraying. Again the losses which mildew is capable of bringing about would appear to have been left out of account altogether. Hence before evaluating the causes of failure of the spraying demonstrations in previous years, it was found necessary to make a thorough study of these factors so as to avoid mistakes. In the course of the study of the mango-hopper problem, it became soon evident that to the cultivator, the only criterion of the success or failure of control measures advocated was the size of the harvest he ultimately got, and consequently it was essential that various factors, such as (1) the volume of flowering, (2) the quality of the setting, (3) the incidence of mildew, (4) the abundance of hopper and (5) the degree of severity of fruit-fall should all be taken into account and studied independently, so as to enable one to bring as many of them under control as possible.

To secure the end detailed above, it was found necessary to study, (*a*) from the botanical point of view, (1) factors affecting flowering, such as the behaviour of individual trees, the influence of the previous monsoon, the influence of the weather, etc. ; (2) the characteristics of different varieties, as regards the time and volume

of flowering, and the relative proportion of perfect to imperfect flowers; (3) factors affecting setting, such as the influence of weather, etc., on the fertilizing agents of the mango flowers, the effect of mildew and hopper; and (4) factors affecting fruit-fall, such as soil moisture, weather conditions, etc.

(*b*) From the entomological point of view, the bionomics of the mango hoppers had to be studied and their control experimented with.

(*c*) From the mycological side the life-history and control of the mildew had to be studied.

Since the conditions of the three main mango areas of Madras, *viz.*, Vizagapatam, Salem and Chittoor, were not similar, it was thought advisable to keep a garden in each of these areas under observation for a series of years so as to enable the department to arrive at conclusions capable of application to the differing climatic conditions of these tracts. For the reasons given above, commencing from the season of 1923-24, a garden in each of these tracts was selected and placed in charge of an officer, not only for conducting spraying experiments to control the hopper and mildew, but also to make observations on various points in connection with the flowering and fruiting habits of the mango, on which but little information was found available.

With the experience gained during the season of 1922-23, a scheme of experiments was devised which was calculated to bring as many of these factors as possible under control and tested in the three centres during 1923-24 and since then repeated with a few modifications during the last five years. A considerable amount of information has, therefore, been accumulated not only on the control measures under trial, but also on the flowering and fruiting habits of several of the varieties of mango found usually cultivated in this province. It is the object of this paper to give a brief summary of the results obtained, the details being proposed to be left out for want of space for inclusion in a more detailed publication.

THE FLOWERING HABITS OF THE MANGO.

In South India, the mango usually begins to put forth its inflorescence in January-February. In some years, however, the flowering may occur much earlier, even as early as November-December. It has been noticed that the volume of inflorescence is generally dependent on the measure of rainfall received during the months of November-December preceding the time of flowering, and varies inversely as the amount of rainfall recorded. If these months happen to be dry, the flowering may be expected to be heavy, while in case rainfall is heavy during this time, the blossoms will probably be late in coming and, possibly, scanty; and very often most of the flushes may run to leaf. There appear to be at least three waves of flowering during a season; the first appears generally in the middle of January, the second in the middle of February, and the third in March. In many cases the last flush may result mostly in leaf-shoots. The volume of inflorescence put forth may also

vary according to the variety of the mango, and different varieties have been found to behave differently under the same climatic conditions.

It was also noted that the same tree may not in general produce equally heavy inflorescences during two successive seasons; a year of abundance is usually followed by a lean year, or at least by one of moderate flowering, and it is rare to have abundant seasons—one closely following the other.

It is a matter of common observation that varieties differ from one another very greatly in the matter of bearing. While a variety like "Bangalora" or "Razumanu" may produce a heavy crop even in a bad season, in the case of a shy variety like "Malgoa" even a heavy flush may not result in a good crop. Such differences are due to the fact that in the normal mango inflorescence two kinds of flowers are noticeable, one being purely staminate bearing only the pollen, and the other —the perfect flower—carrying both the male and the female elements. It is obviously only the latter kind that can develop into fruits, and, therefore, those varieties, in which the proportion of perfect to imperfect flowers is high, have greater chances of producing a good crop, than those with a low ratio, which are consequently but shy bearers.

Factors affecting fertilization and setting.

The perfect flowers have a conspicuous ovary with a filiform pistil, and have one functional stamen and four staminodia. There is also a tumid disc at the base, secreting nectar. The staminate flowers are similar to the perfect ones except for the absence of the ovary and the pistil. The flowers usually open at night, but the anthers dehisce mostly in the morning at about 9 A.M. The pollen is comparatively scant, and has a tendency to stick together except perhaps in very dry weather. In spite of the abundant pollen, fertilization does not look as if it were effected in any large measure by the agency of wind. Numerous insect visitors have been noted on the flower panicles, of which certain flies such as the Blue-bottles, and many wasps and bees figure rather prominently. These are attracted to the honey in the disc, and would appear to convey the pollen from open anthers to the pistils when moving from one part of the panicle to the other. Rainy or drizzly weather at the time of blooming may have the effect of washing off the pollen and thus affecting fertilization injuriously; at the same time during rainy or cloudy days, insects also, as is well known, are apt to be much less active. If there be an attack of mildew the flowers develop an abscission in their stalks and are shed. When there is hopper attack, some of the flower buds may be directly injured by dense oviposition, while in case the outbreak be severe, the panicles as a whole may become covered by deposits of honey dew, so as to prevent the fertilization of the blossoms, or in case wet weather happens to prevail, the honey dew may lead to the development of sooty-mould, which also similarly hinders proper setting.

FACTORS AFFECTING FRUIT SHEDDING.

Fruit-fall may be considered to commence from the time flowers have finished setting, and the first fruits to fall will be those female flowers that fail to get fertilized. The next to share that fate will be the weaker of the fruits that have set, as also those that have been attacked by mildew; and from statistics of fruit-fall taken, it was seen that the greatest loss by shedding occurs within 10 to 15 days of setting, after which the volume of shedding gradually diminishes. Even fairly big, wellgrown fruits have been observed to fall of their own accord, but such occurrences are generally rather rare.

As to the causes that lead to shedding, the factor of mildew is of much importance in the earlier stages. A great number of florets are sometimes affected in this way, but subsequent losses are probably due to the circumstance that far too many fruits are produced in nature than the tree can be expected to retain. The huge number of fruits that set in the beginning is a sort of insurance that nature provides for ensuring that, notwithstanding all adverse factors, at least a fair number of fruits reach maturity. As the season advances and the heat of summer begins to be felt, there is greater and greater difficulty for the tree to support the load of fruits, and consequently it would appear as though there were a competition among the fruits on the tree for sustenance and the weaker ones, presumably because they are unable to draw their supplies from the tree, are automatically weeded out. This idea is supported by the fact that by supplying irrigation to trees after the flowers are set, a great deal of shedding can be obviated. Irrigated trees have, for instance, been found to retain 20 to 30 per cent. more fruits than their controls. Again, similarly, when, by way of experiment, portions of gardens were ploughed and intercultivated, so as to conserve available soil moisture, trees in the treated plots showed far less shedding than those of the controls.

THE MILDEW AND ITS BEARING ON THE MANGO CROP.

The mildew disease has been noted in most parts of the province, though it appears to flourish best in rather cool and moist situations. It appears to attack only the surface epithelium and the parts attacked are the flowers, flower buds and their stalks. In certain cases where the stalk of a fruit had been attacked, but had recovered, the effect of mildew attack was found to result in the skin of the stalk becoming hide-bound preventing it from increasing in girth, as demanded by the physiological needs of the growing fruit. In cases of severe attacks, the entire mass of inflorescence may be lost in the affected trees. In trees where the attack is only light, only parts of the panicles, or sometimes only some of the individual florets may be affected. Whenever the weather becomes favourable, the disease spreads rapidly and may cause a great deal of harm. The mildew is not easily recognizable in the early stages, but assumes a prominent white colour when spore-formation begins, and in the later stages the portions attacked turn

black. In attacked flowers and flower buds a distinct abscission develops at the stalks which causes them to shed prematurely.

It is not improbable that in all those cases where rainy or foggy weather is considered to stand in the way of an efficient fertilization of flowers it is really the mildew that develops and causes the shedding of florets.

THE MANGO-HOPPER AND ITS EFFECT ON THE CROP.

The term " Mangohopper " is in reality a collective name given to three different species of Jassid bugs of the genus *Idiocerus*. *Idiocerus atkinsoni* is the largest of the three species and has the characteristic habit of hiding during day time among the crevices of the bark of the trunk and the main branches of the tree. *I. niveosparsus* is slightly smaller, but can be easily marked out by the prominent white bar crossing its dusky wings, when it is in a resting attitude. This species generally rests on the leaves but may sometimes be found also on the bark along with *I. atkinsoni*. *I. clypealis* is the smallest of the three, and is lighter in colour. It is very rarely seen on the bark of the trunk, but may usually be found resting in numbers on the under surface of leaves. While in some places all the species may at times be found occurring together on the same tree, their relative proportions may vary according to the locality and the tract, and may, moreover, be differently affected by the character of the season of particular years. In South India, however, the most injurious species is *I. niveosparsus*, and though the other two may serve to swell the volume of the damage, the bulk of it appears to be due to this species.

The adult hoppers become active, in general, as soon as the flower buds begin to form and they proceed to lay their eggs in the tissues of the inflorescence, chiefly in the florets and their stalklets. The egg period varies from 4 to 7 days, the nymphal period from 8 to 10 days, and the number of moults which the nymphs undergo is four. The total length of its life cycle from egg to adult stage varies from 12 to 17 days.

The volume of egg laying would appear to depend to a certain extent on climatic conditions, and so far as present observations go, a spell of cold weather, with—for instance, in the neighbourhood of Coimbatore—the minimum dropping to about 55 to 60 degrees F., has often been noted to lead to greatly increased egg-laying activity. In some years two or more broods may occur during the blossoming period of the mango, but the number of generations in any particular year would appear to be dependent on the occurrence of favourable climatic conditions.

The hoppers damage the mango crop in two different ways ; firstly, by the heaviness of egg-laying physical injury is caused to the stalklets as well as the individual florets, so that they ultimately wither and drop. Secondly, the young ones, which hatch in large numbers, crowd together thickly among the florets, and with their sharp sucking tubes, pierce the tissues of the flower panicles and drain their sap. The greater part of the juices thus sucked is, however, excreted after a certain

amount of digestion, as droplets of a sweet fluid known popularly as the "honey-dew"; and as this excretion, falling as it does, in severe cases of infestation, in an incessant and an almost audible drizzle, may often-times be found covering not only the leaves and branches, but also the ground as a fairly thick incrustation, the heaviness of the drain on the resources of the plant, especially at the time of the setting of the crop, will be clearly apparent.

In years when the attack of the hopper is very serious, the amount of fall of honey-dew is so great that even the inflorescences are fully covered. the result being that they are incapacitated from setting. If the weather happens to be dry, the honey-dew dries into a transparent, shiny yellow deposit, but if there be some rainfall, or even a heavy fall of dew, the deposit is partly washed off and in its place sooty moulds make their appearance. If abundant, even these sooty moulds act as distinct hindrances in the setting of fruits.

When the florets have set into fruit and the blossoms have dropped off, the hopper is observed to desert the stalks and betake itself to the tender leaf shoots which are usually put forth after setting is completed. Eggs are laid either in the leaf buds before unfolding or in the midribs and stalks of the tender leaves soon after opening; and young ones may be seen in some numbers on such shoots. There may yet be another brood of hoppers when next a flush of young leaves appears during the monsoon in July, August and September, but the majority of the adult hoppers would appear to bide their time, either on the bark or on the leaves till next the trees put forth their blossoms once again.

Really serious outbreaks of the hopper do not generally occur every year, but in any year it is never entirely absent, and is usually present in greater or smaller numbers. In general, the total output of blossoms by the mango during any year is so enormous that, in spite of a fairly heavy infestation, sufficient numbers of fruits do set and are retained to enable the owner to gather a decent harvest at the end. On the other hand, in years of light infestation or in cases of an efficient control of the hopper by spraying, a heavy setting is noticeable, but though there may be a mass of young fruits in the initial stages, it is usually observable that in the course of a month after setting the majority of them are shed. Apparently it is a physical, and possibly a physiological, impossibility for the tree to bear such a mass of fruits and bring them all to maturity. Observation has shown that the shedding of fruits is greatly influenced by the availablity of the moisture in the soil at the time of maturation of the fruits. By experimental evidence it has been found that trees are able to retain a larger number of fruits (1) if good summer rains are received, (2) if irrigation can be given at the right time, and (3) in case the conservation of soil moisture can be ensured by adopting efficient cultural methods.

REMEDIAL MEASURES FOUND EFFECTIVE FOR THE HOPPER.

Various insecticides have been experimented with for dealing with the mango hopper, of which, crude oil emulsion, fish oil soaps, calcium cyanide, etc., are a few,

Of these, however, the most easily obtainable and efficient, in the experience of the Madras Agricultural Department, has been found to be the fish oil resin soap —manufactured and sold by the Kerala Soap Institute, Calicut, under the trade name of "Insecticidal soap." Mixed with water at a strength of 1 lb. in 10 gallons of water, it forms a fairly effective spray against the nymphs of the hopper. If the spraying is done efficiently and thoroughly so as to reach all the nooks and corners of the inflorescence, the hoppers are surely and effectively destroyed. The tale is, however, different in the case of adults. They are too active to be effectively covered by the spray, so that they escape from its action by flight. By dusting calcium cyanide, it was found possible to bring down even the adults in good numbers, but as even then a good many were noted to escape by flight, and as, moreover, many of the hoppers actually hit revived, this method was not found to be of practical use. From the experience gathered during the last five years, however, all that is necessary would appear to be one thorough spray to the inflorescences as soon as the hopper is noted, and a repetition of the spray after a week's interval if further hatchings of the hopper are noticeable. In bad cases of attack one or more further repetitions of it may be necessary. During years of very serious infestation, the chief form of injury is in the shape of excessive oviposition, and in such cases, since the buds may dry up without opening, the spraying ma not be of much service. Even in such years, however, if begun early enough, spraying has been found to give distinctly useful results. In fact, it is only in years of moderate infestation that conclusive results have not been obtainable, for in such seasons a fair number of fruits do set even in affected panicles in spite of the pest, and since, under ordinary conditions, a large number of set fruits is shed both in the sprayed trees and the unsprayed, the quantity of fruit ultimately left at the time of harvest tends to equalize, so that spraying would look as it were in such cases only a waste of money and effort, quite barren of results. In order, however, to reap the benefits of spraying, efforts should have been made to conserve the soil moisture, by arranging to give the field a thorough intercultivation, and, if feasible, also have the trees given one or two soaking irrigations after the flowers have set. If this were done a heavier stand of fruits would be assured, and the owner would reap the benefit of the spraying given by him.

The question of hopper control, is, therefore, not a simple problem. Tackling the hopper by itself is not a difficult matter, but if thereby an increase in the yield is to be assured, all the other factors involved in the production of a higher yield, such as the incidence of mildew, the existence of insect pests other than the hopper, and the factor of fruit fall, have also to be taken into account and steps taken to counteract their influence.

As a result of the experience of the last five years, the following scheme of control measures has proved to be fairly efficient. 1. A preliminary spray of Bordeaux mixture to be given to the inflorescences as the flowers begin to open for preventing the appearance of the mildew ; to be repeated once or twice if the mildew be not

controlled by the first spray. 2. A thorough spray with fish oil resin soap to be given if hopper is noticed ; to be repeated at intervals of a week in case further hatchings are noticeable. It is necessary in this connection to lay special stress on thoroughness of spraying, care being taken to drench the panicles to make sure that all the hoppers are reached, since inefficient spraying is but waste of effort. A spray of lead arsenate may also be given in case caterpillars are found attacking the inflorescences. 3. Lastly, when fruits have set, a supply of irrigation water to be arranged to be given to the trees in case it be feasible. For the dry system of cultivation, a scheme of thorough intercultivation should be adopted, having for its object an efficient conservation of soil moisture so as to counteract the heavy fruit-fall.

Under the conditions existent in the province of Madras, this scheme has been working fairly efficiently and has given good results. The gardens taken up for spraying have generally compared favourably with their controls. The cost of spraying has, moreover, been surprisingly low and absolutely within the powers of the average cultivator. It may, however, be mentioned here that in general only small trees have been taken for purposes of experiment, not only because they were more convenient for making observations but also because they were more representative of the general size of trees in the dry system of mango-culture. Last year, however, taking advantage of the availability of a powerful sprayer worked by hand—Drake and Fletcher's " Headland "—experiments with the treatment of tall old trees were made and found to be quite within the range of economical spraying.

The results herein detailed, are, however, not claimed to be final. It is probable that various modifications in the details may have to be made as further experience is gathered. For instance, during the five years this question has been under observation, the hopper appeared as a serious pest only on two occasions, once in Chittoor and Coimbatore, and the second time in the Vizagapatam District. Again, very little is known at present as to how the mango mildew lives during the off season when the mango remains without any inflorescence. Its life-history requires a thorough study from the mycological side, and till reliable information is available on its habits and life cycle, its control will continue to be based more or less on methods of an empirical character. Sufficient knowledge is, however, claimed to have been obtained on the question as a whole to enable the Madras Agricultural Department to recommend control measures with a tolerable amount of confidence to the cultivators, although it is recognized that there is still a great deal to learn about it and that the measures at present recommended will have to be modified as further experience is gathered.

NOTE ON POLLEN GRAINS OF COTTON.

BY

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THE object of this note is to describe the details of a method employed in staining cotton pollen grains in order to show the number and arrangement of the pores. In Volume XVII, No. 1, of the *Memoirs of the Department of Agriculture in India, Botanical Series,* entitled "Non-Dehiscence of Anthers in the Punjab-American Cottons," I referred to differential staining with safranin and light green in clove oil, and said that the technique of this double staining was not at that time very precise. By following the schedule given below, however, I have been able to get good differentiation in practically every anther treated. It will be noted that the time of staining in the light green in clove oil is not definitely fixed. The time has to be finally determined by observation. This is due to the fact that, even on the same staminal column, anthers are not all exactly at the same stage of growth, and in consequence the pollen grains themselves are not equally developed. If one anther wall is less permeable than another, penetration of the light green may take longer. Also, similarly, the exine of the pollen grains may not be at the same stage of cutinization from anther to anther. Examination under the microscope of the pollen grains, after they have been dissected out of the anther, is therefore necessary, prior to mounting, to ensure that the pores are visible. In general, however, the schedule given attains the desired result; and if the anthers are, after staining in bulk, brought into paraffin and microtomed, the sections through the pollen grains show a sharp differentiation between the protoplasm and the pollen grain walls.

Details.

The day before the flower is due to open, the staminal column is cut out and fixed in Carnoy's fluid or in absolute alcohol. The anthers must be collected before dehiscence, but the staining seems less easy if the collection of the material is left till the early morning of the day of anthesis and the staminal columns collected then before anther dehiscence.

The stains used were either safranin or erythrosin in 70 per cent. alcohol. Erythrosin gives a more transparent stain than the safranin, and is to be preferred as the pollen grains have to be examined in optical section, when pore counting.

From absolute alcohol in which the material is stored, the anthers are brought down to 70 per cent. alcohol through 85 per cent. alcohol, 1½ to 2 hours being allowed for each step. It does not appear necessary to bring the anthers down through a longer series of alcohols.

The anthers are then transferred to the stain (erythrosin or safranin) and stained in bulk for 24 hours. The stained anthers are then brought back to absolute alcohol in the same stages as above, each stage occupying about the same time. The washing out of the excess safranin or erythrosin is necessary at this stage, to increase the transparency of the pollen grains.

From absolute alcohol the anthers are transferred to a saturated solution of light green in clove oil. The light green replaces the safranin or the erythrosin in the anther wall, and penetrates to the pollen grains and slowly replaces the red stain in the exine of the pollen grain. The anthers may be left in the light green clove oil solution as long as 24 hours.

Single anthers are transferred to a slide under a binocular dissecting microscope and the pollen grains dissected out on the slide. Very fine needles are necessary for this dissection, ground to a triangular point. It increases the ease of manipulation if the needles can be bent easily at the tip when pressed on the slide, without losing their elasticity. The dissection can easily be done in the small drop of light green clove oil solution carried over with the anther. By using the surface tension properties of the fluid, very little practice enables the pollen grains to be separated rapidly from the debris of the anther wall and the connective. This debris should be removed entirely. As the clove oil does not evaporate appreciably, the pollen grains can all be collected into a compact group in the minute drop of clove oil remaining. This group should be examined under the microscope. A one-sixth objective with an Opalite or similar bulb as a source of light without a colour screen, was found satisfactory for this examination. If the differentiation of the pores can be clearly seen, the pollen grains can be mounted direct into canada balsam. The addition, before mounting, of either pure clove oil or xylol to the pollen grain group to remove the light green solution proved to be undesirable. Any excess of the light green clove oil solution must be removed and this, again, can be easily done by taking advantage of the surface tension effects. For, if the needle is pressed slightly on the slide with the point touching the drop of clove oil surrounding the pollen grain group, and a piece of filter paper is brought up carefully along the length of the needle, the excess clove oil runs along the needle and into the filter paper, without disturbing the pollen grains. If the filter paper is brought directly up to the pollen grains, it is found that the pollen grains themselves are also drawn with the clove oil and adhere to the edge of the filter paper, whence it is troublesome to remove them. When the excess clove oil is removed, it will be found that the pollen grains can be made into a little heap and transferred on the point of the needle; or the mass can be slipped direct from one slide to another.

If measurements on the pollen grains are required, a ringed slide must be used. If the ringing material is unaffected by clove oil, the original dissection can be done on the ringed slide; otherwise it is better to dissect out the pollen grains on an ordinary slide, and transfer later.

If the ring on the slide is made of Murrayite, for example, which is softened by clove oil, trouble may occur in the mounting, especially if it has been found necessary to allow the pollen grains to remain on the slide in clove oil for any length of time, as mentioned below.

If, at the stage of dissecting out pollen grains after the anther has been 24 hours in light green clove oil, it is found that differential staining has not been secured, a very small drop of light green-clove oil solution can be added to the pollen grains, and the slide left for six to twelve hours. The slide should be examined from time to time to see if staining is complete.

The staining method given above enables the pores in the pollen grain coat to be clearly distinguished, and by careful focussing, the number of pores on individual pollen grains can be easily counted. When focussed down, the pores on the lower surface of the grain are seen as dark spots on the red background.

The whole of the exine of the pollen grain is stained generally by the light green, so that it may seem remarkable that this method of staining differentiates the pores. The covering of the pore appears actually to be more deeply stained than the remainder of the exine; this deeper staining may not be an actuality but an optical effect due to the lens shaped form of the pore covering shown in the diagram of pores (Diag. I). The light would be concentrated on passing through these portions of the exine.

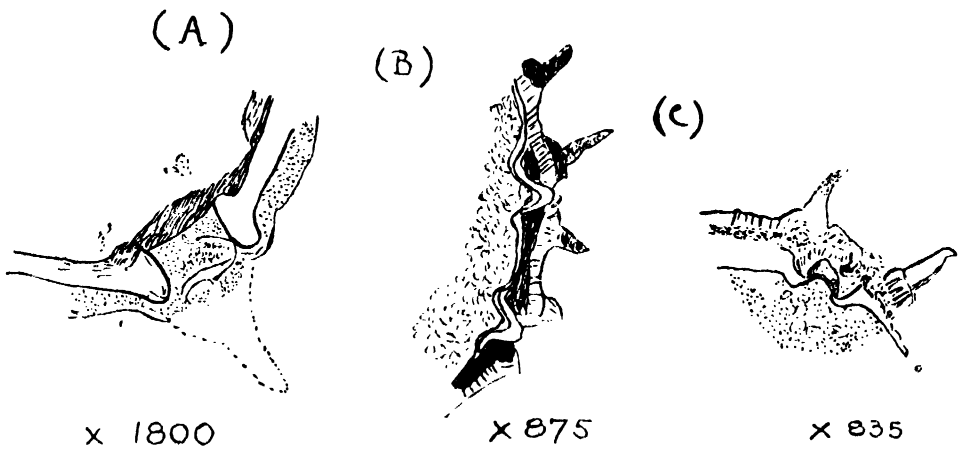

Diagram I.—Transvers e sections through pores of cotton pollen grains.
(A) 4F. Stained with haematoxylin. (B) 285F. Stained with safranin and light green. (C) 285F. Stained with safranin and light green.

Diagram II gives frequency distributions of the number of pores on grains of different varieties of cotton. Although there is some overlapping, these figures show that there seems to be a distinct varietal differences in the number of pores present on a grain.

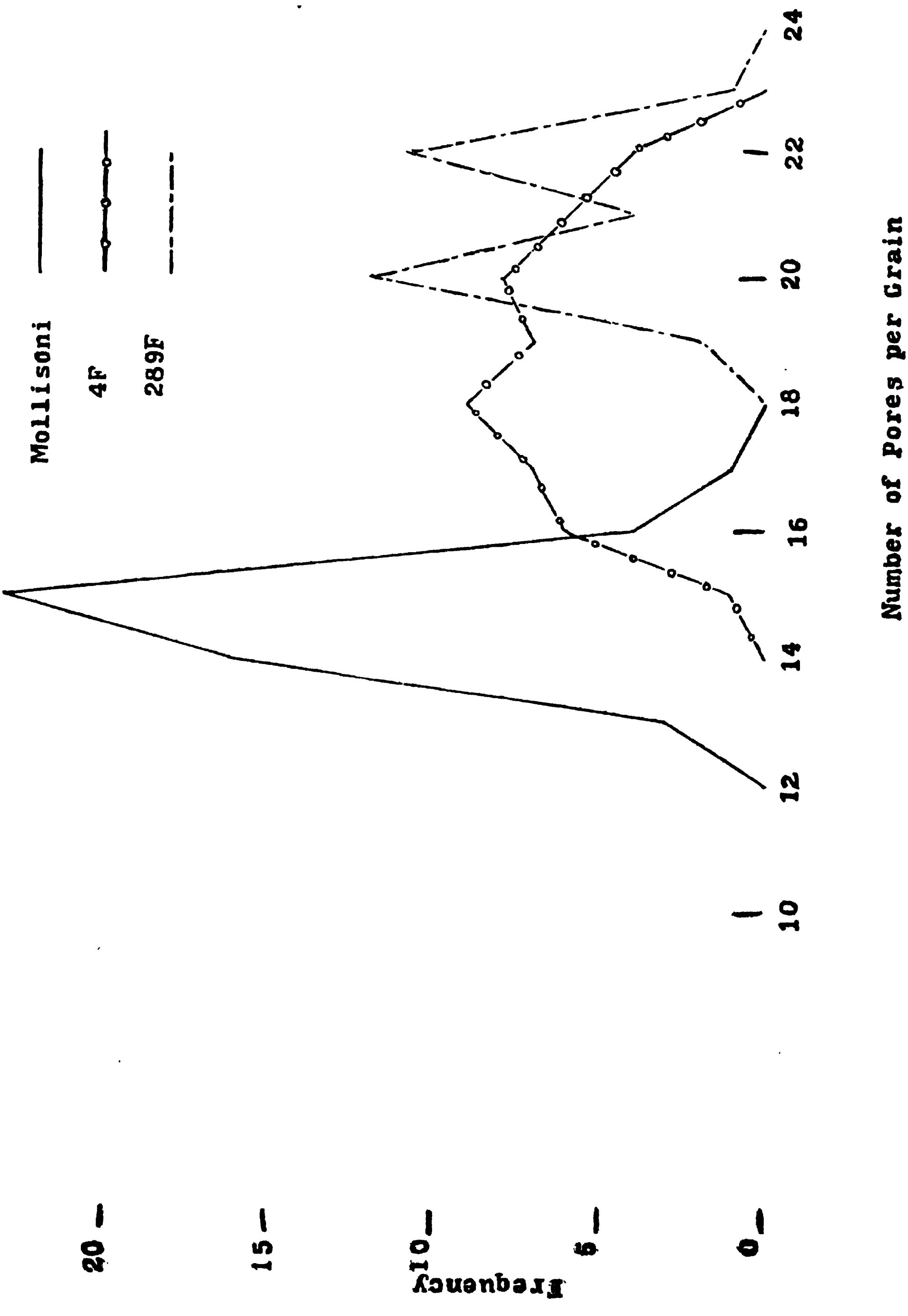

Diagram II.—Frequency Distribution Curves of Pollen Grain Pore Counts.

The table of frequencies below gives figures of pollen grain diameters for Mollisoni, 4F. and 289F. cottons.* As the numbers are small, wide class intervals are used.

Diameter of pollen grain in μ	59·5—69·5	69·5—79·5	79·5—89·5	89·5—99·5	99·5—109·5
Mollisoni	9	45	2	..	..
4F	..	13	19	2	1
289F	..	1	43	7	..

There does not appear to be any connection between the diameter of the grain and the number of pores on the grain in those cases where the same grain was used for both observations. The number of pollen grains in an anther is variable, and does not depend on variety.

Summary.

A method of staining the pollen grains of cotton, which enables the pores to be counted, is described in detail.

Observations on pore number in different varieties, pollen grain diameter, and the total number of pollen grains in individual anthers were made.

Postscript. Nine months after mounting, on slides which had not been exposed to light, the differentiation was still quite clear. The light green fades in slides exposed to light.

* Mollisoni cotton = *G. indicum* var. nov. *Mollisoni* of Gammie, and would come under Watt's *G. Nanking* Meyen, var. *bani*.
4F and 289F are varieties of *G. hirsutum* Linn.

A PRELIMINARY NOTE ON THE CHEMICAL COMPOSITION AND THE ENZYMES OF SUGARCANE POLLEN.

BY

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I. Introductory.

THE present preliminary study, which is based mainly on Paton's[1] work, was taken up with the idea that a knowledge of the chemical composition and enzymes of the sugarcane pollen will help in understanding its physiology.

II. Material and methods.

Portions of arrows were cut about one hour before the opening of the anthers and were brought to the laboratory with the base of the cut portion placed in a bottle containing water. As soon as the bulk of the anthers dehisced, the arrow portion was gently tapped and the pollen dust collected on a clean paper. Fresh pollen was collected every day, and the weighed quantity of pollen was ground with glass and taken up with distilled water and examined for the particular enzyme. Control was run in all cases with pollen that was either boiled or auto-claved.

For chemical analysis, the quantity of pollen available daily was very insufficient. The pollen had therefore to be stored for several days. Freshly collected pollen was first dried in a desiccator over H_2SO_4, and then in an oven at 60—70° C.

III. Experimental.

(*a*) *Enzymes.* (i) *Diastase.* 0·15 gm. of fresh pollen was ground with powdered glass and taken up with 10 c. c. of distilled water in a test tube. To this was added 10 drops of a 1 per cent. solution of starch and a few drops of toluol as a preservative. This was plugged with cotton and kept for 24 hours at the room temperature. The solution was then tested for reducing sugars and for starch.

[1] Paton, J. B. Pollen and Pollen Enzymes. *Amer. Jour. Bot.*, Vol. VIII, No. 10, pp. 471-501, 1921.

A control was run on the same lines with boiled pollen. The control gave only a very faint reduction with the Fehling's solution, while the fresh pollen extract gave very copious reduction; the test for starch showed the absence of starch in fresh pollen, while the control contained starch.

(ii) *Invertase.* 0·15 gm. of fresh pollen in 10 c. c. of water +0·3 gm. of sugar + toluol as a preservative. A control was run with boiled pollen, and the solutions were tested for reducing sugars.

The fresh pollen extract showed almost complete reduction of the Fehling's solution (equal quantities of Fehling's and the extract were taken), while the control gave a very faint reduction.

(iii) *Lipase.* 0·15 gm. of fresh pollen+10 c. c. of water+2 c. c. of N/60 oxalic acid as an activator+2 c. c. of methyl acetate+toluol as a preservative. A control was run with auto-claved and boiled pollen. The solutions were kept for 24 hours at 38—40°C. and titrated against standard alkali (N/10 NaOH), using phenolphthalein as indicator—

Fresh pollen required	8·95 c. c. of standard alkali.
Control required	9·0 c. c. ,,

(iv) *Cytase.* 0·1 gm. of fresh pollen+0·3 gm. of pure cellulose (best Swedish filter paper that was repeatedly boiled with distilled water and washed until free from starch and sugars, was used)+2 c. c. of toluol and water to make 50 c. c. A control was run with auto-claved pollen and the solutions were kept at 38—40°C. for 24 hours and tested for reducing sugars.

There was only very faint reduction, when tested with the Fehling's solution, in both the control and the normal. Tests after 48 hours also gave the same result.

(v) *Proteolytic enzymes. Erepsin.* 0·05 gm. of fresh pollen in 10 c. c. of 1/10 per cent. peptone solution+0·1 gm. thymol. A control was run with auto-claved pollen. The solutions were tested with Gies Buiret reagent after 24 hours.

There was absolutely no colour difference between the control and the normal. The experiment was repeated with a 1 per cent. peptone solution with the same result.

(vi) *Trypsin.* Blood fibrin was prepared from fresh blood and after washing it completely with distilled water, was stained with 1 per cent. congo red, and auto-claved. This was used in the experiments.

10 c. c. of fresh pollen suspension (0·05 gm. in 100 c. c.)+blood fibrin+2 c. c. of N/10 Na_2CO_3 solution+1 mg. thymol. A control was run with auto-claved pollen. The colour of the solution and the nature of the fibrin after 24 hours was noted.

In the normal the solution was deeply coloured and the fibrin had slightly swelled and disintegrated, while in the control, there was slight colour, and the fibrin was the same as before.

(vii) *Pepsin.* 10 c. c. of pollen suspension (0·05 gm. in 100 c. c.)+blood fibrin +2 c. c. of 0·2 per cent. HCl+1 mg. of thymol. A control was run with auto-

claved pollen. The colour of the solution and the nature of the fibrin was noted after 24 hours. There was no colour in the control, while a slight pink colour had developed in the normal and the fibrin had swelled a little.

(viii) *Pectinase.* It was not possible to prepare pure pectin for the tests, so the dried (in a desiccator over H_2SO_4) pistils of *Datura* were used.

0·1 gm. of fresh pollen+0·1 gm. of *Datura* pistil dried in a desiccator and powdered+15 c. c. of water+4 c. c. of toluol. A control was run with boiled pollen and the solutions were quantitatively examined for reducing sugars, by Horne's[1] method.

10 c. c. of the normal pollen extract .	Consumed 2·7 c. c. of standard Fehling's solution (10 c. c. equivalent to 0·05 gm. of invert sugar).
10 c. c. of the control	Consumed 2·6 c. c. of standard Fehling's solution.

(b) *Chemical analysis of sugarcane pollen.*

	Per cent.
Ash	4·84
Starch	16·25
Sugar.	19·49
Proteids	16·66
Ether extract	2·06
Amido compounds	6·26
(The percentages were calculated on dry pollen).	
Moisture	48·7 to 51·1

For moisture determination the pollen was dried in a desiccator till constant weight was obtained. Though as much as 80 per cent. of the moisture was given up in one day, it required about two months for the pollen to become completely dry.

IV. Conclusions and Summary.

Diastase and invertase are present in the sugarcane pollen, while lipase, cytase and erepsin are absent. Indications were obtained of the presence of pepsin and trypsin. The results about the presence of pectinase were not conclusive.

The chief constituents of the sugarcane pollen are carbohydrates (starch and sugar) and proteids. Water constitutes a fairly large part (about 48 to 51 per cent.).

[1] Horne, W. D. Rapid method of Glucose determination. *Louisiana Planter and Sugar Manufacturer*, Vol. LXXXI, No. 1, p. 1, 1928.

MY EXPERIENCES OF A MODERN FARM TRACTOR.

BY

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[The following article gives an account of the writer's own experience with a motor tractor, used partly for cultivation and partly for cotton-ginning, in the black-cotton soil tract of Berar. The allowances which should be made for depreciation, repairs and loss of time through breakdowns under Indian conditions are still a matter of opinion and will naturally vary with the circumstances under which the machine is used. Estimates of the useful working life of a tractor are equally varied.—Editor.]

Many attempts have been made in the past by different contributors, show organizers and agricultural firms in India to give some figures and calculations as to working cost and other details for ploughing with motor tractors, but many, if not all, of them have based their remarks on the results of short trials and demonstrations lasting only a few hours or, at the most, a few days, when every part of the machinery under trial is put in excellent order and the best and expert attention is given to it while being demonstrated. Thus anything judged from such trials of short duration and any conclusion drawn, is bound to be erroneous and misleading. I, therefore, propose to place before the landed aristocracy and the rural public some results of my experience with some modern agricultural machinery.

I have about 800 acres of land under direct cultivation. A "McCormick Deering", or commonly called an International Tractor (15–30 H. P.), has been working on my farm for the last four years. It is being used for the following jobs:—

(1) From the beginning of December till the end of March every year, for running a small ginning factory consisting of 8 gins. (The actual working days are about 75 days.)

(2) From the first week of April till the break of the monsoon for ploughing.

(3) In certain years, from the end of the rainy season, say, from the middle of September for a month or so, for discing land prior to *rubi* sowing.

I shall take each item separately.

Ginning factory.

The factory consists of 8 gins (Platt Bros. single roller "McCarthy" cotton gin). Each gin, if worked separately, and if applied power direct, requires about

$2\frac{1}{2}$ H. P. But as intermediate gearing or second motion shaft is used (in order to work more than one gin) some extra power is consumed, which in practice is found to be $\frac{1}{2}$ H. P. per gin. Therefore 8 gins require 24 H. P. Mine is a 30 H. P. motor and therefore it pulls the load very easily. It is always safe and advisable to work an engine at a lighter load as it saves so much wear and tear.

The factory is worked for ten hours daily (in two periods of five hours each with an interval of an hour). This gives time to factory labourers to take food and have some rest. In the meantime the driver looks to lubrication, cleaning, etc.

The running cost comes to about (*i*) Rs. 43-14-3 for the tractor and (*ii*) Rs. 33-7-2 for the factory (8 gins) as follows :—

TABLE I.

Working cost of tractor per day.

	Rs.	A.	P.
1. Driver at Rs. 60 per month	2	0	0
2. Cleaner at Rs. 15 per month	0	8	0
3. Kerosene—8 tins (4 gallons each)	24	0	0
4. Petrol	0	3	0
5. Mobiloil—1 gallon	3	0	0
6. Gear oil—$\frac{1}{4}$ gallon approximately	0	8	0
7. Grease and cotton waste	0	2	0
8. Interest (Table III, b, 2)	3	9	7
9. Depreciation (Table III, c, 2)	6	10	8
10. Repairs and renewals (Table III, d, 2)	3	5	4
Total cost per day	43	14	7

TABLE II.

Working cost of factory per day.

	Rs.	A.	P.
1. Fitter at Rs. 90 per month	3	0	0
2. Oilman at Rs. 20 per month	0	10	6
3. Nine feeder women (one per gin and one extra)	2	13	0
4. Three *kapas* carriers at As. 8	1	8	0
5. Two men for filling and pressing bags	1	0	0
6. Two women for removing cotton seed	0	10	0
7. Mochi at Rs. 20 per month	0	10	6
8. Ginning oil—2 gallons	2	0	0
9. Breakage and repairs (spare parts, roller washers, beltings, etc.) as shown in Table IV, d, 2	6	0	0
10. Interest on the outlay (Table IV, b, 2)	7	3	2
11. Depreciation (Table IV, c, 2)	8	0	0
Total cost per day	33	7	2
Combined cost of (*i*) and (*ii*)	77	5	9

TABLE III.

Interest, depreciation and spares for tractor outfit.

(*a*) 1. Estimated to cost about Rs. 6,000.
2. Maximum working period (on my estate) 5 months.
3. Average working period (ploughing on a farm or with a private owner) 3½ months.

	Rs.	A.	P.
(*b*) 1. Interest on Rs. 6,000 at the rate of Rs. 9 per cent. per annum (the whole amount of interest is chargeable on 5 months or 150 days)	540	0	0
2. Interest per day at the above rate	3	9	7
3. Interest per acre of land ploughed (counting 5 acres a day)	0	11	6
(*c*) Life of tractor is taken as six years—			
1. The depreciation value comes to about 16·66 per cent. per annum (chargeable on 5 months or 150 days actually worked)	1,000	0	0
2. Depreciation per day	6	10	8
3. Depreciation per acre (at 5 acres a day)	1	5	4
(*d*) 1. Cost of repairs and spare parts as actually found (average of last four years)	500	0	0
2. Ditto per day	3	5	4
3. Ditto per acre	0	10	8

TABLE IV.

Interest, depreciation and spares for factory establishment.

	Rs.	A.	P.
(*a*) 1. Estimated to cost about Rs. 6,000 (including building, construction work, erection, etc.)	6,000	0	0
(*b*) 1. Interest on Rs. 6,000 at Rs. 9 per cent. per annum	540	0	0
2. As the working days are only 75, this amount of interest, *i.e.*, Rs. 540 is to be charged on 75 days and therefore it comes per day to	7	3	2
(*c*) 1. Depreciation at 10 per cent. (to be charged on 75 days only)	600	0	0
2. Ditto per day	8	0	0
(*d*) 1. Cost of repairs and spare parts for the season (75 days)	450	0	0
2. Ditto per day	6	0	0

The outturn of clean cotton per gin comes to about 5 maunds or 410 lb. per day (of 10 hours). Ginning charges are Rs. 2½ per maund which gives an income of Rs. 12-8-0 per gin per day or Rs. 100 for the whole factory per day.

The net income, therefore, comes to Rs. 22-10-3 per day.

PLOUGHING.

Ploughing is done in summer only which in this tract (Melghat Taluq of the Amraoti District) cannot be commenced earlier than April as the cotton crop occupies a longer period, the last cotton picking is done in March, and as the wheat is also harvested in that month. The working cost of ploughing by tractor per day is shown in Table V.

TABLE V.

	Rs.	A.	P.
1. Driver's pay at Rs. 60	2	0	0
2. Cleaner at Rs. 15 per month	0	8	0
3. Kerosene (5 tins for 5 acres in 10 hours or 2 gallons per hour)	15	0	0
4. Petrol—¼ gallon	0	6	0
5. Mobiloil—1 gallon	3	0	0
6. Gear oil—½ gallon	1	0	0
7. Grease and cotton waste	0	4	0
8. One pair of bullocks, a cart and a driver or waterman for fetching water from well	2	0	0
9. Interest (Table III, b, 2)	3	9	7
10. Depreciation (Table III, c, 2)	6	10	8
11. Repairs and renewals (Table III, d, 2)	3	5	4
Total cost of ploughing per day	37	11	7

From the above Table, we find that the total cost for ploughing per day is Rs. 37-11-7 which comes to about Rs. 7-8-8 per acre (on the assumption of ploughing five acres a day). But this is only true for a particular day or for a short period, say, a week or so. In actual practice we find that—

(*i*) Continuous work for the whole week is never done as the driver must have at least a day in a week for rest, marketing and looking thoroughly over his machine to see that everything is in perfect order and for doing petty repairs, etc.

(*ii*) Similarly continuous work for the whole month is not done as (*a*) sometimes the driver may be required to go to town to get some repairs done there in a workshop or at a blacksmith's, and so on, or (*b*) at times he might be compelled to wait for a spare part (having broken one by accident or any other cause) which has been ordered from Bombay. If unfortunately the place where the tractor is working is at a long distance from a railway or post-office, as in my case, considerable time is lost in transit,

and therefore taking the whole month's average it is not possible to plough more than 100 acres a month.

Thus counting as above 100 acres a month, the working cost of ploughing is increased per acre. The fuel and lubricating charges per acre remain constant while all other charges such as driver's pay, interest on the outlay, etc., are proportionately enhanced. The ploughing charges, therefore, may go as high as Rs. 10 per acre.

DISCING.

The working cost per day is nearly the same as for ploughing, but the day's work is greater. On an average 8—10 acres are disced. The discing charges, therefore, come to nearly half that of ploughing.

Since the soil in my tract is stiff black, very big clods come up after ploughing in the hot weather. The disc harrow, therefore, is not a good implement for working as a clod crusher after ploughing in the black cotton area. I use it only when the soil is moistened after a good shower of rain or, at the end of the rains, for the preparation of *rabi* land.

Conclusions.

1. An International 15—30 H. P. tractor can be used for field work and belt (or stationary) work as well.

2. It can drive eight gins quite easily. The total cost per day (of 10 hours) for both tractor and factory (8 gins) comes to Rs. 77-5-9.

3. The outturn of clean cotton per gin when worked with the tractor is 5 maunds or 410 lb. for 10 hours.

4. Taking a day's average it can plough about 5 acres of land (black cotton soil) in summer. The working cost per acre comes to Rs. 7-8-8.

5. In the black-cotton soil tract a power disc harrow cannot be used for breaking clods after the land is ploughed.

6. The tractor can easily disc about 8—10 acres of land after a good shower of rain (the only idea being that there should be enough moisture in the soil). The working cost comes to about Rs. 4 per acre.

THE USE OF SELFED SEED IN MAINTAINING THE PURITY OF IMPROVED COTTONS

BY

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Foreign cottons do not retain their character for a long time in their new habitat. Cambodia cotton from Indo-China lost its staple in Madras. Broach cotton introduced into Dharwar fell off in its ginning percentage from 34 to 29, within five years. Similarly, improved strains deteriorate even in the tract of their origin. The 4 F. cotton of the Punjab is reported to have fallen off in recent years. All these facts point to the necessity of devising some means, by which deterioration can be successfully stopped, otherwise the valuable work turned out by plant-breeders will be in danger of being lost soon after it reaches the hands of the grower.

The Kumpta-Dharwar tract of Bombay grows two cottons, *viz.*, Kumpta and Dharwar-American. One strain in each has been isolated by selection. The selected strains, which are well known in the tract under the names of "Dharwar I"[1] and "Gadag I",[2] are superior to the cottons from which they are selected, in all the three economic characters. They went into the district in the year 1917; since then their cultivation is extending, the average area under each cotton for the past 5 years being about 100,000 acres. The crop of this vast area is, on the whole, pure.

The purity of these improved strains is not, however, due to some accident or the absence of disturbing factors. They have not yet entirely replaced the old varieties, and have, therefore, to grow in the midst of inferior material. The ginning of all cottons is done either on the double roller gins or saw gins; and as these are more difficult to clean than the single roller gins, the possibilities of seed mixing are greater in this tract. That the improved strains even under these circumstances have remained pure is due to the fact that a scheme of seed multiplication, has been carefully evolved from the beginning, by which a regular supply of fresh seed is maintained and the accumulation of aberrent types is kept under control.

The causes which are responsible for deterioration in cotton are two, *viz.*, (1) natural cross-pollination taking place in the field, and (2) the mixing of seed occurring in the gins and in the godowns. Both these causes are at work when two or more varieties are cultivated in the same tract. If these two factors are controlled, the purity of a cotton can be maintained for any length of time. Mutants, no doubt, appear in pure cottons; and if they possess undesirable characters, as they often do, they form as starting points for deterioration; but they are so very rare that they need not be noticed in our present consideration.

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[1] Kottur, G. L. Kumpta Cotton and its Improvement. *Mem. Dept. Agri. India, Bot. Series*, Vol. X, No. 6.

[2] Kottur, G. L. Dharwar-American Cotton. *Bombay Dept. of Agri. Bulletin*, No. 106.

Cottons cross freely in nature. The extent to which this occurs at a particular place, however, varies somewhat with the variety and environment. Long-styled cottons are liable to cross more than the short-styled. The proximity of foreign pollen increases the chances, and cross-pollination is, for this reason, more common on breeding stations where a number of cottons are grown side by side. In the district, the danger is certainly less ; but as it cumulates, the effect is sure to be felt after a time. The immediate result of crossing is not, on the whole, undesirable. The hybrid vigour is, on the contrary, a decided advantage. Deterioration, however, begins with every seed that is produced by these hybrids. The resulting plant, which is almost always inferior, affects the qualities injuriously and, in addition, contaminates the seed by crossing with the neighbouring plants. Hence all crossing requires to be rigorously stopped to keep up the standard of any cotton.

Cottons flower in the morning, the exact time varying with the variety and the temperature of the day. When the petals expand, the anthers and the stigma are not generally ready. The former burst soon afterwards and liberate a large quantity of pollen. This, however, does not reach the stigma immediately, especially in those flowers which have the stigma projected beyond the reach of anthers. During this interval, pollen sucking insects, of which the bees are the principal, visit the flower, and if they happen to bring any foreign pollen with them, they transfer it to the unpollinated stigma. In this way all cross-pollination takes place in cotton ; the two necessary requirements for it are (1) the opening of the petals and (2) the presence of the bees.

The necessity for preventing cross-pollination is already recognized in all breeding works on cotton. Thin paper bags are generally employed for the purpose. They are tied to the buds, enclosing one flower in each. Sometimes entire plants are so protected, and this saves some trouble. Few breeding stations have specially erected glass houses for growing cottons which they want to self. All these devices are intended to keep the insects out. They are efficient as long as the covers remain intact. But if they slip or give way, both of which are not unusual, their efficiency suffers in proportion. Apart from this danger, the cost and trouble involved is so great, that none of these methods can be considered as practical for production of pure seed on a large scale.

A simple and more efficient method [1] was discovered at Dharwar in the year 1916. It was then found that cleistogamic cottons suffered least from crossing. This suggested the use of rings in place of paper bags. These are easily made of galvanised iron wire (20″) which sells at Rs. 20 per cwt. The wire is coiled on a hand reeling machine, using different rods for different cottons. These coils, when cut, give the rings. For most of the Indian varieties, rings of 6 mm. in diameter are suitable, while American cottons require larger ones according to the size of their buds. All that is needed for preventing crossing, is to slip these rings on the buds, some time before they begin to open. A piece of cotton thread which is

[1] Note on protecting cotton flowers. *Agri. Jour. India*, Vol. XIV, 1919.

attached to the rings is tied to the pedicels. When the petals drop, the rings hang on the pedicels and this enables the pickers to distinguish the selfed bolls from the non-selfed. The procedure is so simple that a girl can easily handle about 1,000 buds in one morning.

The rings sit firmly on the tips and do not allow the petals to expand. They come off only when the flowers shrivel on the third or fourth day. Pollination takes place inside the cone without any trouble or disturbance. Ringing has no disadvantage ; on the contrary, it protects the pollen during the wet weather when the percentage of successful bolls is always greater from ringed flowers. The method is easy, safe and effective, and can be conveniently employed for producing large quantities of selfed seed. In fact, 60 to 100 lb. of selfed seed of Dharwar I are produced every year at an extra cost of Rs. 2-12-0 per pound. As three pounds of seed are generally required to dibble one acre, absolute purity of cotton can be secured at an extra expenditure of Rs. 6 per acre. In this way 6,000 to 9,000 lb. of pure seed is raised on the Government farm at Dharwar and distributed to selected seed growers for further multiplication. The produce of the seed-growers, which is collected and ginned under the careful supervision of the departmental officers, is sufficient to drill 10,000 to 15,000 acres. Care is taken to secure this area in one or two blocks situated near the central cotton markets. Seed multiplied on these blocks is purchased by the cotton sale societies for general distribution in the tract. It covers annually about 200,000 acres, which is the limit under the existing arrangements for supervision.

The farm seed is distributed to seed-growers every year, and the produce of the growers reaches the owners in the blocks. In this way a regular fresh supply is maintained. A large quantity of the *kapas* grown in the tract comes to the co-operative sale societies for sale, which classify the *kapas* with the assistance of the Agricultural Department and guarantee the ginning percentage, cleanliness and purity. This encourages the buyers to give full premium which profits the growers. The ginning percentage is a valuable test of purity for both these varieties ; the records of ginning percentage kept by the societies clearly show that the two improved cottons have well maintained their superiority in this character. Spinning test results of these cottons are also available for 5 years, and though the spinning value of a particular cotton varies from year to year due to climatic differences, the tests show no indication of deterioration in the cottons. Indeed, Dharwar I cotton has varied very little in its spinning capacity. The cotton as grown in the tract has been found to be suitable for spinning 34 counts in four years and 32 counts in one year.[1] The standing crop of the whole tract is also inspected from time to time. Last year's inspection showed that the highest number of rogues that could be detected was six per acre. All these facts go to prove that the cottons have maintained their superiority for a period of ten years, and this is due to precautions taken in seed production.

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[1] Turner, A. J. *Technological Reports on Standard Indian Cottons*, 1928.

VARIATION IN LINT LENGTH IN COTTON.

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INTRODUCTION.

It is well known that the prime function of a plant-breeder is the purification of strains in the various characters he is dealing with. It is during this process that all his knowledge of inheritance of characters and his powers of discernment are put to the test. For, if perchance, any error in judgment or any slight indifference in observing proper precautions were to creep in, all his labours in the evolution of strains will be cast to the winds; for, the strains will not be what he proclaims them to be.

The fundamental feature of a pure line is that it is capable of producing progenies similar to the parent. Johannsen defines a pure line as " the progeny of a single self-fertilized individual of a homogenous factorial composition ". Thus, the important condition is homozygosity of the strain, which when fulfilled entitles the strain to be dubbed pure. Hence the measure for purity is the measure adopted to find out homozygosity. In all the characters, especially, in the metrical attributes which belong to the multiple factor type, the co-efficient of variability forms a preliminary index of purity, such that, if a line is found to possess a high co-efficient of variability, it is taken to connote genetic impurity. But, it is also well known that physiological and environmental factors cause variation even in genetically pure material. It thus becomes preeminently incumbent on the plant-breeder to eliminate, if possible, or to assess correctly the influences that are brought about by physiological and environmental disturbances before he is in a position to analyse the fluctuations engendered by the differences in genetic constitution.

In cotton, where the harvesting period extends for more than a month, the variations induced even in genetically pure strains will be very great. No apology is, therefore, needed to deal in this paper with the dispersion in lint lengths obtained from individual plants.

It will often be found in the course of this paper that the differences in the lengths cited will be fractions of a millimeter and as such may create an impression in the

minds of the readers that they are not worth worrying about. But it must be said that these small differences, when in combination, so increase the co-efficient of variability for the whole population as to mask the influences of heterozygosity.

MATERIAL.

The data discussed here were obtained from single plants of strain Nandyal 14 (*G. indicum*) grown entirely under rainfed conditions, and from single plants of strain Coimbatore 1 (*G. hirsutum*) grown under irrigation, at the Cotton Breeding Station, Coimbatore, during the year 1924-25. Small dated tags were tied to the flowers on the days they opened. Each boll when burst was collected separately with the pericarp and preserved carefully with its label which also carried the date of its picking.

For the determination of lint length, the method described by Hilson[1], *viz.*, combing the lint on the right side of the seed and then measuring the distance between the central line (raphe) and the edge of the halo with a pair of dividers, was adopted.

VARIATION IN LINT LENGTH OF BOLLS OBTAINED IN DIFFERENT PICKINGS.

As mentioned before, the chief peculiarity in the picking of cotton is that it extends over a longer period than in the case of other crops, and during this period the plant has to face different vicissitudes of life. Balls[2] has recorded that the lint length is affected by water shortage and its effect is at its maximum when the bolls are sixteen days old. Kelsick[3] has found at St. Kitts that the length of Sea-Island cotton depends on the water supply the plant receives at the critical period of the development of the bolls, and works out a correlation between the rainfall during the critical period and the ultimate length obtained. Harland[4] is of opinion that lint length would become shorter if there is drought during the time of boll development. Kearney and Harrison[5] have demonstrated that "there is a marked tendency for the lint to increase in length from the base to the summit of the plant and that there is a correlation of the value $+0{\cdot}497 \pm 0{\cdot}047$ between the number of the fruiting branch from the first sympodial node and the lint length". But Ewing states that the length in long stapled Upland varieties is shorter in the later than in the earlier pickings due to the frequent droughts in the Mississippi State. Burd[6]

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[1] Hilson, G. R. Methods of examination of certain characters in cotton. *Pusa Agri. Res. Inst. Bull.* 138.

[2] Balls, W. L. Analysis of agricultural yields. *Phil. Trans. Roy. Society*, Vol. B-206.

[3] Kelsick, R. E. Some observations on the relations of lint length to rainfall. *West Ind. Bull.*, XVII.

[4] Harland, S. C. Improvement of the yield of Sea-Island cotton by the isolation of pure strains. *West Ind. Bull.*, XVII.

[5] Kearney and Harrison. Length of cotton fibre from bolls at different heights in the plant. *Jour. Agri. Res.*, XXVIII.

[6] Burd, L. H. Report on the research work carried out at the Cotton Expt. St., Vincent. *Empire Cotton Growing Rev.*, II, No. 3.

states that " the mean maximum lint length of a strain is seriously depreciated by a heavy fall of rain about nineteen days after flowering ". Humbert and Mongford [1] have declared that " variations in lint lengths are found to occur in the same boll, in the same lock and in seed side by side in the same lock, and that the position of bolls on the plant and the date of opening of the boll had no consistent influence on the length of lint ". Zaitzev [2] found that the lint length and twist increase with age. Whether similar differences are found in cottons grown under conditions obtained in South India and whether they are statistically significant when found, has to be decided.

The produce of two plants, 3/5 and 3/24, in strain Nandyal 14 was sorted out according to the picking dates ; all the seeds in each boll were combed and measured and the results are shown in Table I.

TABLE I.

Plant No.	Picking dates	Bolls picked	No. of seeds combed	Average	Stand. dev.	Plant No.	Bolls picked	No. of seeds combed	Average	Stand. dev.
3/5	5th-11th March .	10	132	24·735	1·9457	3/24	1	6	26·167	1·172
	12th-18th March .	3	44	24·636	1·3158		No boll			
	19th-25th March .	4	67	25·209	1·2037		5	95	26·0	1·523
	26thM-1st April. .	17	303	25·092	1·6059		8	138	24·848	1·489
	2nd-8th April . .	15	249	25·667	1·819		15	210	25·169	2·943
	9th-15th April . .	12	194	26·021	1·813		15	251	25·912	2·152
	16th-23rd April .	5	74	24·743	2·212		36	558	24·387	2·315
	23rd-29th April .	No boll					2	33	24·606	1·873
	30thA-6th May . .	6	78	25·487	1·2683		No boll			

In order to find whether the differences observed are statistically significant or not, the method adopted for testing homogeneity in a material of this kind is applied. " If a population obtained from p localities can be described by a sample N in size, M in type and E in variability, and if a sub-sample can similarly be defined by n, m, and σ, then the ratio $\frac{m-M}{\sigma_{m-M}}$ will have a standard deviation which will seldom exceed $1 + \frac{.6745}{\sqrt{2s}}$ where s is the number of lines involved.[3] The formula[4] for $\sigma_{(m-M)}$ is

$$\sqrt{\frac{E^2}{N} + \frac{\sigma^2}{n}\left(1-\frac{2n}{N}\right) - \frac{n(M-m)^2}{(N-n)}}$$

[1] Humbert and Mongford. Variation in certain lint characters in a cotton plant and its progeny. Extract in *Empire Cotton Growing Rev.*, IV, p. 391.

[2] Zaitzev. Reports from Turkestan Plant-breeding St. Summary in *Empire Cotton Growing Rev.*, V, No. 3.

[3] Harris, J. A. *Am. Nat.*, Vol. 45.

[4] Pearson, Karl. Note on the significant or non-significant character of a sub-sample drawn from a sample. *Biometrika*, Vol. V.

TABLE II.

Picking period	Plant No. 3/5			Plant No. 3/24		
	m—M	$\frac{m-M}{\sigma(m-M)}$	Stand. dev. of the ratio $\frac{m-M}{\sigma(m-M)}$	m—M	$\frac{m-M}{\sigma(m-M)}$	Stand. dev of the ratio $\frac{m-M}{\sigma(m-M)}$
1	—·491	3·13		+1·129	2·69	
2	—·590	2·98				
3	—·017	0·116		+1·123	7·13	
4	—·134	1·60		—0·029	0·22	
5	+·441	4·29	2·028±·159	+0·292	1·64	3·03±·18
6	+·7945	7·05		+1·035	8·25	
7	—·483	1·97		—0·488	6·30	
8	*nil*	*nil*		—0·271	0·84	
9	+·261	1·81				

Table II indicates that the standard deviation of the ratio $\frac{m-M}{\sigma(m-M)}$ in both the cases, exceeds 1, and it has to be concluded that the differences observed in the lint lengths of the seeds from bolls picked on different dates in the two plants under study are significant. It is also observed that there is no definite relation between the lint length and the date of picking in the variety of cotton studied. The latter observation is not in agreement with the conclusions arrived at by Kearney and Harrison.[1]

VARIATION IN LINT LENGTHS IN LOCKS OF THE SAME BOLL.

If an examination is made at the time of dehiscence of a boll, a difference in the position of the topmost seed in each lock will be found. In some locks, the funicle of the first seed will be attached on the right side of the central axis (placental axis)

[1] *Loc. cit.*

and in others on the left. It was thought that this irregularity in the location of the seeds depending upon the position of the first seed might disturb the lint length. In order to elucidate this point, the lint lengths of seeds of the first position, in both the types of locks in the same boll in three plants, were compared with the aid of "Student's" method.[1] Table III clearly demonstrates that there is no appreciable difference in the lengths.

TABLE III.

Plant No.	Position of the seed in the lock	Difference in lint lengths (Right minus left)	Value of z $\frac{\text{Difference}}{\sigma \text{ Difference}}$	Value of P	No. of readings	REMARKS
Nandyal 14						
2/5 . .	First seed	+ ·41 mm.	·214	·7557	44	Not significant
3/4 . .	Do.	—·19 mm.	·098	·6929	27	Do.
3/24 . .	Do.	+ ·56 mm.	·330	·9365	25	Do.

VARIATION IN A LOCK.

The seeds in a lock are, in a majority of cases, arranged alternately, and the positions of the second and the subsequent seeds depend upon that of the topmost or the first seed, *i.e.*, if the attachment of the first seed is on the right side all the seeds holding the even rank will be on the left and those holding the odd, on the right; if the attachment of the topmost seed is on the left, this order is reversed. In working out the variation of lint lengths of seeds within a lock, the combed length on the right side has been taken as the criterion for comparison. It may be mentioned here that as the seeds are from the same lock, there will be a high correlation amongst them, and naturally this has to be taken into consideration when the standard deviation for the difference has to be worked out. The common formula used in such cases, *viz.*, $\sigma_{A-B} = \sqrt{\sigma_A^2 + \sigma_B^2 - 2 r_{AB} \sigma_A \sigma_B}$ where σ stands for the standard deviation and r for the correlation co-efficient between the variables, is the one followed. The correlation co-efficient has been obtained by the product moment method without the application of Sheppard's correction to the second moment. The results are summarized in Table IV.

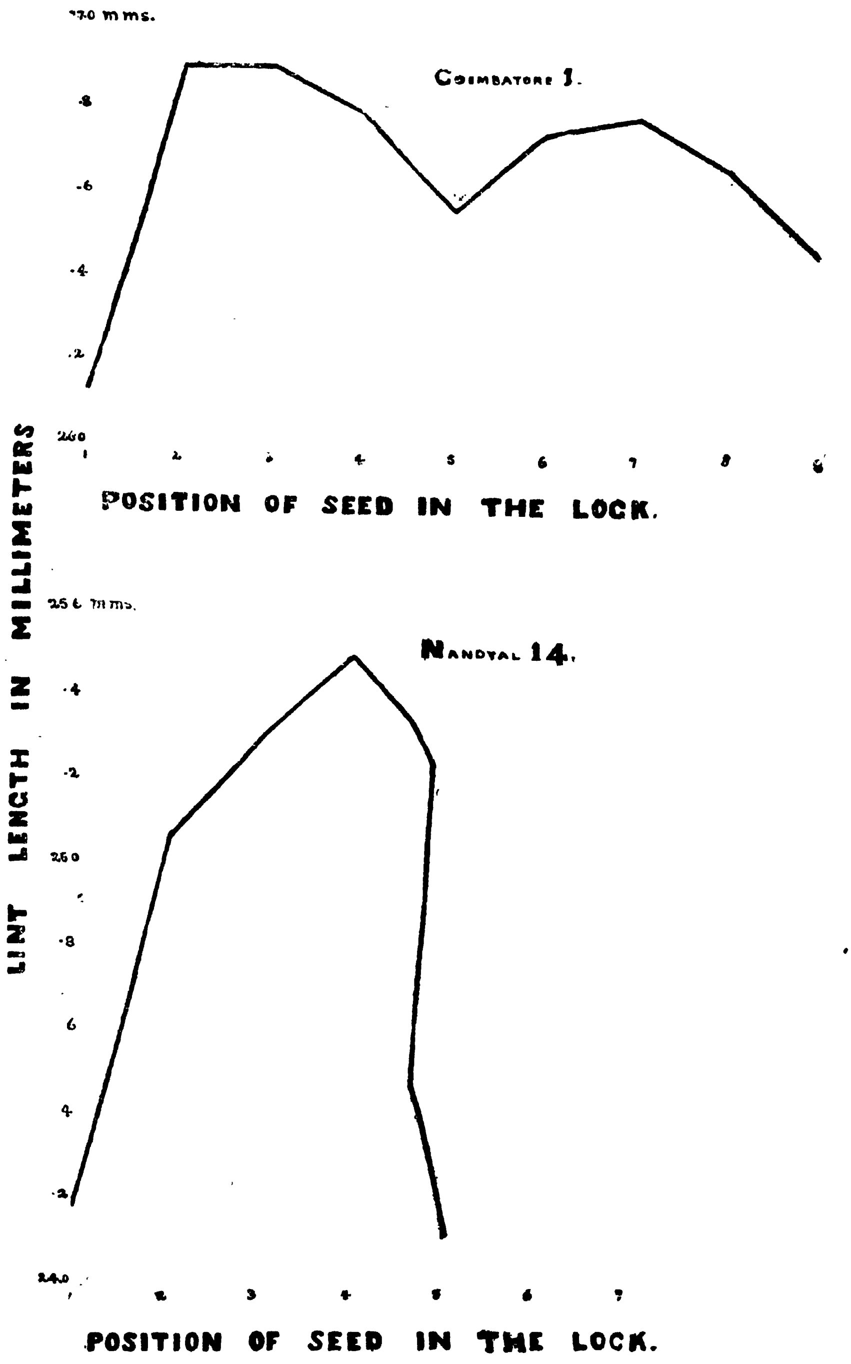
[1] Student. Probable error of the mean. *Biometrika*, VI.

TABLE IV.

Plant No.	Difference in length between 1st and 2nd seeds	Difference * / P. E. of the difference	Difference in length between 2nd and 3rd seeds	Difference * / P. E. of the difference	Difference in length between 3rd and 4th seeds	Difference * / P. E. of the difference	Difference in length between 4th and 5th seeds	Difference * / P. E. of the difference	Difference in length between 5th and 6th seeds	Difference * / P. E. of the difference	Difference in length between 6th and 7th seeds	Difference * / P. E. of the difference	Difference in length between 7th and 8th seeds	Difference * / P. E. of the difference	Difference in length between 8th and 9th seeds	Difference * / P. E. of the difference
	(2—1)		(3—2)		(4—3)		(5—4)		(6—5)		(7—6)		(8—7)		(9—8)	
								Cambodia Coimbatore 1.								
51	+·92	4·39	—·25	·84	—·09	·35	—·38	1·68	+·47	2·13	—·09	·53	+·15	·64	—·50	3·42
52	+·90	5·93	—·25	1·79	—·23	1·27	—·32	1·95	+·45	2·81	—·36	2·85	—·25	1·43	+·05	·27
60	+·54	4·08	—·38	2·74	—·03	·25	—·15	·08	+·16	1·37	+·10	·80	+·15	1·19	—·85	5·83
62	+·62	4·96	+·45	2·40	—·07	·33	—·19	1·18	+·33	1·94	—·14	·82	—·55	3·30	+·18	·75
64	+·31	2·08	+·35	2·41	+·06	·38	+·18	1·08	—·07	·43	+·02	·08	—·07	·33	+·16	1·01
80	+·92	7·34	—·02	·10	—·60	4·21	—·29	2·31	—·48	3·04	—·04	·24	—·70	4·06	—·29	2·12
88	+·93	6·95	—·15	·79	—·19	1·13	+·02	·14	—·13	1·01	+·14	·90	—·07	·57	—·58	3·50
264	+·85	6·25	+·49	2·36	—·24	1·36	—·17	1·14	0	0	+·07	·55	+·25	1·79	—·39	2·22
269	+·87	4·53	+·04	·23	—·40	2·82	—·18	1·23	+·08	·71	+·34	2·40	—·35	2·09	—·43	1·76
304	+·95	4·58	—·35	1·41	—·15	·50	—·42	2·42	+·08	·44	+·35	1·39	—·43	2·02	—·39	1·21
								Nandyal 14.								
2/5	+·76	7·60	+·29	3·23	+·15	1·46	—·08	·71	—·85	7·18	—·15	·91				
2/6	+1·17	9·71	+·22	2·26	+·55	5·68	—·23	2·10	—·78	7·62	—·58	4·25				
3/4	+·97	9·93	[illegible]·20	2·15	+·16	1·62	—·16	1·48	—·[illegible]6	6·32	—·43	3·39				
3/5	+·89	8·95	+·07	·66	+·38	3·39	—·37	3·62	—·56	1·80	—·10	·55				
3/17	+·77	7·47	+·90	7·96	—·10	·99	—·23	2·01	—·71	4·96	—·45	2·24				
3/24	+1·00	10·43	+·40	4·43	+·20	2·23	—·16	1·70	—·85	7·68	—·34	1·74				
• 4/5	+·76	9·03	+·10	1·22	+·44	5·16	—·37	3·82	—·72	8·08	—·13	1·15				
4/17	+·82	4·36	+·44	3·36	+·01	·07	—·24	1·80	—·69	4·47	—·46	2·12				
All plants combined.	+·886	*24·15	+·24	6·94	+·19	5·32	—·23	6·09	—·74	17·94	—·32	5·57				

* When the ratio Difference exceeds 3·2 it is taken that the results are statistically significant.

It will be seen that in both the strains, the first seed has indubitably a shorter staple and practically there is no difference in the lengths amongst the other seeds of the lock in strain Coimbatore 1, while there is a definite peak in the fourth seed in Nandyal 14 (Text fig.). This suggests that in Coimbatore 1, it matters very little which seed in a lock is selected for combing, provided the topmost seed is excluded,



LINT LENGTH IN MILLIMETERS
27·0 mms.
Coimbatore 1.
·8
·6
·4
·2
26·0
1
2
3
4
5
6
7
8
9
POSITION OF SEED IN THE LOCK.
25·6 mms.
Nandyal 14.
·4
·2
25·0
·8
6
4
·2
24·0
1
2
3
4
5
6
7
POSITION OF SEED IN THE LOCK.

but in Nandyal 14 it will be erroneous to do so. It is very likely that in some strains differences in lint lengths of seeds in the same lock will become more marked, and it is, therefore, highly desirable to take only the seeds from a particular position in the lock for comparison.

Humbert and Mongford [1] have found variation in lint lengths of seeds located side by side in a lock. But Henry [2] has declared, from the study of Egyptian and Sea-Island cottons, that if there are eight seeds in a lock, the lowest two are the shortest in length, while the middle four have the longest fibres and the two seeds at the top are intermediate in length. His criterion for judgment has been the average length of single fibres stretched by a moistened finger. Hilson [3] has shown that "the average combed length is a close approximation of the average single fibre length", and, hence, it would appear that the above results obtained at Coimbatore are not in confirmity with Henry's conclusions.

Variation in a seed.

It is a matter of common knowledge that there is a wide fluctuation in the lint lengths of fibres produced on the same seed. Usually, the longest fibres are found round the chalazal end and the shortest at the funicular end. Nevertheless, the maximum length taken along a radius has been found to be a correct method for the determination of lint length. Hilson [3] has further demonstrated that, by combing lint on one side of the seed, a considerable time is saved without impairing the efficiency in the determination of lint length. It may occur to some whether there is no difference in the variations in the lengths of fibres borne on the right and the left sides of a seed. Lack of symmetry in the distribution of hairs on a seed will also strengthen the doubt. To obtain information on this point, each seed in all the locks of two plants in both the strains has been combed on both sides and the corresponding measurements are recorded in Table V which shows that the right side has a longer staple in all the four plants and that the differences are statistically significant.

TABLE V (*a*)

Nandyal 14 (*G. indicum*).

Plant No.	Difference in mm. in lint length according to position of the seed in the lock (Right—Left side)								Difference / P. E. of the difference	No. of determinations	Remarks
	1	2	3	4	5	6	7	For all positions of seeds in a lock			
3/5	0·63	1·14	1·74	1·28	2·13	1·27	..	1·4028	33·985	643	Significant.
4/17	1·36	1·43	1·51	1·63	1·27	1·25	1·63				

[1] *Loc. cit.*

[2] Henry. Determination de la valeur commerciale des fibres de cotton. *La agricutlure pratique des payschands*, 1902.

[3] *Loc. cit.*

Table V (*b*).

Coimbatore 1 (*G. hirsutum*).

Plant No.	Difference in mm. in lint length according to position of the seed in the lock (Right—Left side)										Difference / P. E. of the difference	No. of determinations	Remarks
	1	2	3	4	5	6	7	8	9	For all positions			
52 and 60 combined	0·87	1·06	0·76	1·05	0·63	1·12	0·93	1·15	0·92	·95009	20·35	501	Significant.

With a view to elucidate this point further, it was considered advisable to compare the single fibre lengths on both sides of the seeds. The figures given on pages 17 and 18 in Hilson's bulletin on "Methods of examination of certain characters in cotton" were examined for this purpose. Since the positions B & C on the right side correspond to D & E on the left, the differences between the average single fibre lengths at positions B & E and those between the average single fibre lengths at positions C & D have been worked out and tabulated (Table VI).

Table VI.

Position of seed	Average single hair length in position B (Right)	Average single hair length in position E (Left)	Difference (Right—left)
1st seed	21·9	20·3	1·6
2nd seed	23·5	22·5	1·0
3rd seed	24·5	22·1	2·4
4th seed	24·9	24·1	0·8
5th seed	24·6	24·3	0·3
6th seed	26·9	26·3	0·6
7th seed	26·5	25·4	1·1

Average Difference $= +1·11$

$$Z = \frac{1·11 \times \sqrt{20}}{·656}$$

$P = ·99999$

Position of seed	Average single hair length in position C (Right)	Average single hair length in position D (Left)	Difference (Right—Left)
1st seed	21·5	20·9	0·6
2nd seed	24·5	23·8	0·7
3rd seed	23·0	23·0	0·0
4th seed	24·4	24·1	0·3
5th seed	24·6	24·8	—0·2
6th seed	28·9	26·8	2·1
7th seed	28·5	25·4	3·1

Average Difference $= +0·94$

$$Z = \frac{0·94 \times \sqrt{20}}{1·12}$$

$P = ·99999$

These differences are significant and go to confirm the observations recorded in the previous paragraph. Whether such peculiarities are confined only to certain strains or whether they only indicate a general phenomenon, will have to be settled only after an examination of other cottons.

Researches in N. Carolina [1] have shown that there are more stomata near the butt or the chalazal end of the seed. Further investigation is necessary to see if the irregularities in the distribution of the stomata or the variation in the branching of the primary veins on the seed are responsible for the differences in lint length on the same seed.

Discussion.

Balls, Harland and Hilson have shown that the average lint measurements of three or five seeds picked at random from the produce of a plant will represent the average length for that plant. The fundamental statistical conception on which the above conclusion is based is that the whole population, from which the three or five readings are taken to be a random sample, is almost normally distributed. But it has been shown in the preceding paragraphs that there are definite differences in lint lengths amongst bolls from different pickings, amongst seeds of the same lock and even on each side of a seed. These observations may suggest that if all the lint measurements of a plant are tabulated, they will not form a normal population and the physical constants obtained from a random sample will not, therefore, correctly represent those of the entire population. As a test, the curves of the distributions of lint lengths from all the seeds produced by two plants in strain Nandyal 14 were determined and they were found to belong to Type IV in one plant and to Type I in the other amongst Pearson's curves, and their constants are :—

	Plant No. 3/24	Plant No. 3/5
β_1	$\cdot 21242 \pm \cdot 05519 =$	$\cdot 012194 \pm \cdot 0318$
$\beta_2 =$	$3 \cdot 6035 \pm \cdot 24982 =$	$3 \cdot 0712 \pm \cdot 1264$
$\varkappa_2 =$	$\cdot 29502 \pm \cdot 17787 =$	$\cdot 4224 \pm \cdot 64554$
	Type IV.	Type I.

These types are very close to the normal curve of error and hence the means of random samples will tend to become normally distributed. But, if any slight correlation is found to exist between the individuals composing the sample, the distribution of the means will not be normal [2]. With the object of clearing this doubt the intra-correlation co-efficient was worked out by forming a symmetrical table and a value of—$\cdot 026 \pm \cdot 01734$ was obtained. This proves that, if the selection of seeds

[1] *Expt. St. Rec.*, Vol. 57.

[2] Student. Distribution of means of samples which are not drawn at random. *Biometrika*, Vol. VII.

is at random, there will be no correlation amongst the variables and it is correct to assume that the distribution of means of samples will be normal. This has been attested by the actual finding of the curve of distribution of 500 means of five readings per sample taken at random in plant 3/24 of strain Nandyal 14, the respective values of β_1, β_2 and $\varkappa_2$ being ·00001, 2·8656 and –·00003. This warrants the statement that the physical constants for a sample of five readings will correctly represent those of the whole population in the case of lint length.

But, in the case of the plant-breeder who is more interested in examining the purity of the progenies than in assessing the average value of each of his selections, the question of the exact relationship between the entire population and its sample does not trouble him much. His main pursuit is the determination and the elimination of heterozygosity in the material he is handling. At the outset, he has to check, or entirely keep out, if possible, all the factors, physiological and environmental, that go to enhance the variation in the material, so that the variation due to genetic constitution alone remains to be tackled. In the case of lint length, it has been shown that differences in the picking dates and in the positions of seeds selected in a lock induce variation. If this variation is to be reduced to the minimum, the simplest course seems to be to collect separately the bolls burst on a single day when the picking happens to be at its maximum and comb out, for the determination of lint length, the lint of the middle seed of the lock, *viz.*, the third, fourth or fifth, respectively, in the case of selections where the majority of the locks contain seven, eight or nine seeds per lock. Six readings per plant will suffice to bring out the inherent variability in the plant. Burd [1] is also of opinion that cottons for comparison between strains should be obtained from flowers which open on the same day.

SUMMARY.

It is shown in this paper that—

(1) there are definite differences in the lint lengths of seeds produced in different pickings,

(2) there is no definite relation between lint length and the date of picking,

(3) there is no significant variation in lint length between lock to lock in the same boll,

(4) the topmost seed has the shortest staple and that there may be, in certain strains, differences in lint lengths of seeds according to their position in the lock,

(5) the lint length on the right side of the seed is greater than that on the left.

The authors take this opportunity to express their gratitude to Mr. G. R. Hilson, Cotton Specialist, Coimbatore, for his suggestions.

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[1] *Loc. cit.*

A COMPARATIVE STUDY OF THE GERMICIDAL EFFICIENCY OF E. C. AND FORMALIN ON BACTERIAL SPORES.*

BY

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THE floor and walls of sericultural nurseries in Bengal require to be sprayed with some disinfectant in order to kill the pebrine spores and thus reduce the mortality of silkworms. Until recently, a dilute solution of formalin was being used for the purpose. Since the appearance in the market of electrolytic chlorogen or E. C. (a cheap disinfectant, containing about 2·0 per cent. available chlorine, manufactured by the electrolysis of 20 per cent. rock salt solution under definite electrical conditions and subsequent stabilization with the addition of slaked lime), the Bengal Department of Agriculture have begun to use this product in place of the costly formalin.

As accurate information, however, had to be obtained regarding the dilution of E. C. to be used for spraying purposes, at the request of the Director of Agriculture, Bengal, experiments were conducted in our laboratory to determine the comparative germicidal efficiencies of E. C. and formalin, *i.e.*, the dilutions and the times of contact necessary to destroy the spores of common soil bacteria. Bacterial spores were selected instead of the pebrine spores, as the latter could not be grown in artificial culture media. The procedure adopted was a slight modification of the Rideal—Walker's method to determine the phenol co-efficient of different antiseptics and was as follows :—

To flasks of 100 c.c. sterile water was added 1 c.c. of emulsion of the spores of bacteria to be tested, the contents well shaken and different amounts of the disinfectant added to bring about the requisite dilutions. The flasks were then shaken frequently, and after definite intervals of time 1 c.c. was taken by means of a sterile pipette and introduced into 10 c.c. of peptone bouillon which was incubated at 30°C. By noting the absence of growth in the peptone bouillon tubes after 48 hours, the antiseptic efficiency of the particular dilution could be ascertained. But there was one defect in this method. Owing to high concentrations of the disinfectants used in our experiments, the absence of growth in bouillon tubes might as well be due to the suppression of the spore germination by the amount of disinfectant introduced in 1 c.c. inoculum. Thus, *e.g.*, when a dilution of 1 : 40 formalin was tested, the peptone bouillon tube gave no growth for six days, after which

* A paper read at the Indian Science Congress, Madras, 1929.

it became cloudy. On making an ordinary agar plate using two loopfuls for inoculation from the same dilution, the plate was full of colonies after 24 hours' incubation at 30°C. In subsequent experiments, therefore, making plates on ordinary agar, using 2 loopfuls for inoculation, was resorted to in place of inoculation into bouillon tubes. A control plate was always made from the diluted emulsion before the addition of disinfectants to see how many spores were originally present in the inoculum.

Experimental.

The organism selected for tests was *B. Mycoides*, being easily distinguishable on plates by its characteristic cotton-wool-like colonies. An old culture on agar was emulsified in 50 c.c. sterile water which was heated to 80°C. for five minutes to kill all the vegetative cells and to distribute the spores evenly. After cooling, 1 c.c. of this emulsion was diluted to 100 c.c with sterile water in flasks to which the various amounts of E. C. and formalin were added to bring about the requisite dilutions of disinfectant. At the end of 5, 15 and 30 minutes, plates were made on ordinary nutrient agar, using 2 loopfuls for inoculation. The results are given in the following Table :—

Table 1.

B. Mycoides spores in sterile water.

Control 60 colonies

Disinfectant	Dilution	Time of contact		
		5 minutes	15 minutes	30 minutes
E. C (Pusa) Available Cl_2 2·02 per cent.	1 : 100	32	3	*Nil*
	1 : 200	32	7	*Nil*
	1 : 400	20	*Nil*	*Nil*
	1 : 1000	30	1	*Nil*
Formalin (Merck).	1 : 10	1	*Nil*	*Nil*
	1 : 20	100	36	27
	1 : 50	90	90	15
	1 : 100	62	72	47

From the above it will be seen that E. C. in a dilution of 1 : 1000 destroys the spores completely with 30 minutes' contact, whilst formalin even in a dilution of 1 : 20 is unable to do this. The superiority of formalin over E. C. is evident in its destruction of spores within five minutes in a dilution of 1 : 10.

In a second experiment, the spores of *B. Subtilis* were tried instead of *B. Mycoides*, since the spores of the former are one of the most refractory of all bacteria. The technique of dilution and plating was the same as in the previous experiment. The results are given in Table II.

TABLE II.

B. Subtilis spores in sterile water.

CONTROL about 2,200 colonies.

DISINFECTANT	DILUTION	TIME OF CONTACT		
		5 minutes	15 minutes	30 minutes
E. C. (Pusa) Available Cl_2 2·02 per cent.	1 : 100	580	360	430
	1 · 200	numerous	200	340
	1 : 400	,,	460	290
	1 : 1000	,,	340	240
Formalin (Merck)	1 : 10	150	8	*Nil*
	1 : 20	640	480	360
	1 : 40	numerous	520	320

The results in this experiment were altogether different from the previous one. Here E. C. even in a dilution of 1 : 100 did not bring about the destruction of spores with a contact period of 30 minutes; whereas in the case of *B. Mycoides* spores, a dilution of 1 : 1000 destroyed most of the spores within 15 minutes. A dilution of 1 : 10 formalin which was effective in killing all the spores of *B. Mycoides* within five minutes, was ineffective in the case of *B. Subtilis* spores within that time, but had to be prolonged to 15 minutes to destroy a large percentage of the spores.

The above tests with *B. Mycoides* and *B. Subtilis* spores were repeated twice to make sure that there has been no mistake in these experiments and they only confirmed the previous findings, as will be evident from the following Tables.

TABLE III.

B. Mycoides spores in sterile water.

CONTROL 27 colonies

DISINFECTANT	DILUTION	TIME OF CONTACT		
		5 minutes	15 minutes	30 minutes
E. C. Pusa Available Cl_2 2·02 per cent.	1 : 100	7	*Nil*	*Nil*
	1 : 200	8	*Nil*	*Nil*
	1 : 500	18	1	*Nil*
	1 : 1000	10	1	*Nil*
Formalin (Merck)	1 : 10	*Nil*	*Nil*	*Nil*
	1 : 20	20	8	5
	1 : 40	24	2	4
	1 : 100	28	33	18
	1 : 200	36	22	28

TABLE IV.

B. Subtilis spores in sterile water.

CONTROL 90 colonies.

DISINFECTANT	DILUTION	TIME OF CONTACT		
		5 minutes	15 minutes	30 minutes
E. C. (Pusa) Available Cl_2 2·02 per cent.	1 :100	64	65	52
	1 : 200	60	51	53
	1 : 400	69	71	50
	1 : 1000	75	56	67
Formalin (Merck)	1 : 10	52	1	*Nil*
	1 : 20	86	80	65
	1 : 100	62	55	107

Having ascertained that 30 minutes' contact with E. C. even in a dilution of 1 : 100 was insufficient to kill the refractory spores of *B. subtilis*, longer times of con-

tact and lower dilutions were next tried. Table V gives the results of the experiment.

Table V

B. Subtilis spores in sterile water.

Control 75 colonies

Disinfectant	Dilution	Time of contact					
		5 min.	15 min.	30 min.	60 min.	90 min.	120 min.
E. C. (Pusa) Available Cl_2 2·02 per cent.	1 : 10	40	35	*Nil*	*Nil*	*Nil*	..
	1 : 100	..	..	70	54	21	3
	1 : 200	..	..	56	70	14	2
	1 : 400	..	..	28	27	*Nil*	*Nil*
	1 : 1000	..	..	32	1	*Nil*	*Nil*

From the above, it is evident that a 90 minute contact is necessary to kill all the spores of *B. Subtilis*, and that the higher dilution of 1 : 1000 is more effective in accomplishing the object than either 1 : 100 or 1 : 200.

From a perusal of the results of tests with formalin, it appears that a definite strength of formalin, *viz.*, 10 per cent. is necessary to effect complete destruction of spores of both the bacteria, whereas in the case of hypochlorite, the duration of contact appears to be important.

The explanation for the difference in behaviour of these two disinfectants probably lies in the difference in their chemical action on the concentrated protoplasm of the spores. Formalin acts by coagulating the albumen and to effect this a definite concentration of the same is necessary. In the case of hypochlorite, however, the nascent chlorine is liberated slowly on dilution and this destroys the protoplasm of the spores by oxidation, and the longer it is in contact, the more thorough is its action. Hence the inefficacy of E. C. in high concentrations with a contact time of 15 minutes and the complete sterilizing effect of dilutions of 1 : 1000 when the time of contact is 90 minutes.

The difference in behaviour of E. C. towards the spores of *B. Mycoides* and those of *B. Subtilis* might be due to the more highly refractory nature of the spore coat of the latter, resulting in a longer time being taken by the disinfectant to penetrate the spore wall. This observation is also confirmed by the facts that, according to previous investigators, a longer time, about 50 minutes, is necessary to kill the spores of *B. Subtilis* in boiling water than those of *B. Mycoides* for which 10 minutes is enough, and that 10 per cent. formalin requires a longer period of contact to effect complete destruction of the spores of *B. Subtilis* than is necessary with the spores of *B. Mycoides*.

SELECTED ARTICLES

MORE OBSERVATIONS ON THE METHOD OF FIELD EXPERIMENTATION.*

BY

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Probably no part of the work of the Agricultural Adviser has been the subject of more persistent criticism than the attempt to apply the experimental method to the elucidation of practical farm problems. Hitherto the attack has come on the one hand from farmers, sceptical of the practical value of all work done on less than fieldwide scale, and distrustful generally of "theorists" and all their works, and on the other hand from the statistician, skilful computer of the "odds on" and stickler for the "dead cert". To these must now be added (J. M. A., July, 1929, p. 341) a third class of critic—the economist, the arch-realist of the advisory service, privileged of access to the very arcana of farm practice, insistent upon the balance sheet as the final criterion of the value of any professed contribution to the advancement of the farming industry.

Of the three critics, the statistician alone does not dispute the validity of the experimental method. He is solely concerned to secure that the interpretation of the results of the experiment shall be kept within the limits imposed by the degree of reliability of the data obtained. If, for example, the method of experiment is incapable of measuring with a fair degree of certainty differences smaller than 10 per cent., he insists that no significance must be attached to differences below this figure. Much of the criticism of experimental work finds its point in neglect to observe this obvious precaution, the fault thus lying, be it noted, against the experimenter and not against the experimental method. It is here where the word of criticism is still required, and we shall return to the point later.

The attack of the farmer—reinforced now by the economist—comes from quite a different angle, being directed against the experimental method itself. "The trouble . . ." says Mr. Dixey, "is due . . . . to the attempt to use the experimental method at all for purposes for which it is not suitable." True, a few lines later he hedges with the more guarded expression of opinion that "the experimental method is not the best method of studying farm practice," but the whole trend of his argument indicates that the "at all" of his first thoughts gives the more accurate indication of his views.

* Reprinted from *Jour. Min. Agri. London*, XXXVI, No 5.

On what grounds, then, are we to abandon the attempt to help agriculture by "practical" experiments? Firstly, because they are carried out under conditions which are "purposely artificial"—"an essential characteristic of any experiment" we are told. Secondly, and "even more serious," because of "the impossibility under such circumstances of relating the results to the economic factors of cost, and so to profit".

The memory of the oldest experimenter will not carry back to the day on which these criticisms of agricultural experiments were first made, and an apology is surely necessary for exhuming once more the corpse that has been so frequently buried and disinterred!

THE EXPERIMENTAL AND SURVEY METHODS COMPARED.

In what respects is the ordinary experiment—say a manurial trial—artificial? Small plots? These can be adjusted in size to suit the taste of the critic, if he is prepared to foot the bill. The advantage of the larger area lies mainly in the psychological effect upon the farmer observer. Control of amount of seed and manures applied? Surely copying the practice of the best farmers! Preparation of the land? This is usually done in precisely the same fashion as the rest of the field, with the same implements and labour, often before the site of the experiment is actually selected. The only operation in starting the experiment which need disturb the ordinary routine of the farm in the slightest is the application of the manures, and the disturbance amounts only to a loss of time, the mode of application remaining "practical". Throughout the growth of the crop no distinction of treatment need be made between the experimental area and the rest of the field. Finally, at harvest the only discrimination necessary is a little adjustment of routine to ensure that the produce of each experimental plot is kept separate, again involving only a slowing down of the rate of progress of the harvesting operation. Wherein is the "artificiality" of all this—so gross as to condemn the whole business of experiment? Apparently only in the use of the measuring-chain and the weighbridge, implements which will hardly be described as "artificial" when used for the purpose of securing more accurate data for the economic surveyor!

It may be true that in the measurement of very fine differences the greater care exercised by the experimenter may enable him to demonstrate a difference which cannot be secured in the cruder routine of the farmer, but differences of this order of magnitude would not in any case have any significance for practice. Whatever the defects of the experimental method, "artificiality" is surely the least, and to suggest that this is a potent factor in delaying the improvement of practice among the general body of farmers is pure nonsense. Far more potent factors require no seeking in the files of the advisory economist!

As to the condemnation of the experiment because its results are not directly translatable into terms of financial profit or loss—this criticism can only apply to

experiments which are directly designed to give information on financial results, otherwise it is pointless. If the object of the experiment, however, is simply to compare the crop yields obtained by two different treatments, it can only be judged with reference to the degree of success with which it achieves this object. If the experimenter is foolish enough to draw conclusions beyond the warrant of his data he may rightly be derided, but the value of his experiment is thereby in no wise affected. The "economic survey" is subject to precisely the same limitations; the validity of any conclusions drawn from it is determined by the character and reliability of the data accumulated. Any adventure in interpretation beyond the limitations thereby imposed is pure speculation, and open to criticism as such without affecting the value of the survey.

The only issue for debate therefore is whether an experiment which is not capable of being summed up in a reliable account of profit and loss can be of any practical use to the farmer. We may concede that until the economics of the problem have also been investigated it cannot represent more than the half-loaf, but as such surely it is not to be despised. We certainly cannot accept the assertion that the plot experiment "cannot give any real guidance as to cost or profit". There should be no difficulty in supplying the rest of the loaf by experimental methods if the necessary facilities and resources are available. Indeed, it can only be by the application of scientific method to the investigation of costs and profits that reliable results can be obtained. The idea that the "plot experiment" is incapable of supplying reliable economic data can only arise from the curious obsession that "plots," whether of land or of live stock, must necessarily be small, uneconomic units. No such restriction is imposed upon the method of "plot experiment," and it is only considerations of cost and labour which have caused experimenters to limit their activities hitherto so largely to small-scale experiments which can only give results in terms of physical output.

It is true that the results obtained at any one experimental centre are strictly valid only for the conditions obtaining at that centre during the period of experiment, and consequently by themselves cannot serve as a basis for generalization, but the remedy for this is found precisely on the same lines as in the economic survey by multiplying the points of observation.

Even with this amplification, however, the results of the experiment may show a degree of variability which compels the honest experimenter to interpret them as warranting only modest odds in favour of Practice A as against Practice B, leaving it to the individual farmer to use his own judgment, fortified possibly by a rough experiment, as to whether his own conditions fall within the majority or the minority group. This moral honesty on the part of the experimenter must be accounted to him for virtue, and no lower standard can be accepted from the exponent of any other method of providing guidance for the farmer.

But whilst we fail to find any real weight in the argument of the economist against the experimental method, we are conscious of its difficulties and defects in other

directions, and would only too gladly surrender it for any adequate alternative that might be less laborious and less costly. Does the "survey method of economic research" provide such an alternative? To us it would appear to suffer from the fundamental defect that a survey can only deal with existing practice, and can do little or nothing therefore to accelerate the introduction to practice of new discoveries as they emerge from the research laboratories. Such discoveries can only come within the purview of the economic surveyor when they have become sufficiently widely established in practice to furnish an adequate number of recording centres for the purposes of the survey.

In most cases, however, the jump from the artificial conditions of the laboratory to the commercial farm is too violent to be taken at a single bound, and many discoveries which have subsequently proved to be of real practical value have been severely disparaged in their earlier stages through premature introduction into practice, with consequent damage to the prestige of scientific research and loss to the farmer. It is rarely that the results obtained in the laboratory, pot-culture station or metabolism cage can be safely introduced into practice without being first thoroughly tested out under controlled conditions which approximate closely to practice, in order that the farmer may have some assurance of a reasonable chance of success before risking his money. This function the "practical experiment" can fulfil admirably; the economic survey only comes into action at the later stage when the farmer himself has started to "experiment". Its function is rather to supplement than to replace the experiment. Before the farmer starts to experiment he should have some guidance as to the chances of success. Farming is inevitably a speculative occupation, but with the results of experiments before him the farmer can at least restrict his "flutters" to the "odds-on" candidates amongst the newcomers in the way of professed advances.

Even within the limits of existing practice, however, does the economic survey method promise to give more explicit guidance than the experimental method? Judging by the illustrations given by Mr. Dixey this would seem to be very doubtful. From a survey of the records of 130 farms in 1926 he demonstrates that the farmer who drilled his sugar beet at less than 20 inches between the rows tended to get a heavier crop of beet than the man who drilled at a greater width. This point, however, was apparently established even more conclusively by the application of the experimental method at only five centres in the west of England! In Mr. Dixey's results out of every 100 farmers using the 20-inch (or narrower) drilling, 38 obtained less than 10 tons of beet per acre, and 62 over 10 tons per acre—chances of roughly 6 to 4 in favour of obtaining a crop of 10 tons or more with the narrow spacing. Out of every 100 farmers using the wider spacing (over 20 inches) 54 obtained less than 10 tons, and 46 over 10 tons—or chances of roughly 11 to 9 against obtaining a crop of 10 tons with the narrow spacing. Put in another way, we might say that in the first group there would be 38 farmers dubious as to the superior merits of the narrow spacing, and in the other group 46 farmers similarly dubious. Surely

no very clear guidance here *to the individual farmer*. By contrast the *experimental* results show an enhanced yield with the narrower spacing in every case, and abundant confirmation can be adduced from experiments elsewhere that, when other factors are as nearly equal as possible, the advantage of the narrower spacing, though not invariable, is shown with a much higher degree of frequency than the survey results suggest.

The position is no better when we turn to the information given by the survey as to the financial outcome of the different spacings, as again we find only modest odds in favour of the narrower spacing, and the individual farmer is still left under the necessity of testing for himself the degree of applicability of the general conclusion to his own particular circumstances.

It is perhaps not without intention that Mr. Dixey has selected for his illustrations the sugar beet crop, since in this case reasonably accurate data for production—of roots at any rate—are available in the factory returns. But what of other crops for which the production data obtained by the economic surveyor are liable to be little more than crude estimates ? How can the analysis of such data give more than the roughest guidance as to the comparative merits of different practices ?

Moreover, to return to the sugar beet illustration, what assurance have we that the differences in results between the two groups of the survey analysis were simply due to the different widths of spacing the beet ? The intelligent and enterprising farmer taking up a new crop will exert himself to find out what is regarded as the best practice amongst those who have experience in growing the crop, and in the case of sugar beet he would soon discover the prevalence of the narrower spacing in the old-established beet-growing areas, and a considerable amount of confirmatory evidence from experimental work in this country. Is it not possible, therefore, that the level of intelligence and enterprise was higher among the " survey " farmers using the narrower spacing than in the other group, and that this may have contributed materially to the differences in the results recorded ? The " surveyor " would doubtless shrink from any attempt to grade his clients according to " capability ", but may he not unwittingly have done so roughly by his classification on the basis of spacing !

We have laboured the point, perhaps to the verge of absurdity, in order to demonstrate the uncertainty which must necessarily attach to any conclusions arrived at by the survey method as to the comparative merits of different variations of technique, in view of the many other variables by which the results may be affected. Only by taking farms on each of which the different variations have been practised side by side can this difficulty be overcome—but this is the experimental method !

We are unable, therefore, to accept the economic survey as more than a partial and very imperfect substitute for the experimental study of a wide range of practical farming problems, but we welcome its development as a valuable adjunct to the latter, furnishing the means of obtaining a rough check as to the extent to which the experimental results can be incorporated into farm practice with success.

Difficulties of the Experimental Method.

At the same time we would not deny that the experimental method has been sadly misused in its application to the study of agricultural problems. As far as past experimental work is concerned, the most serious defects have perhaps lain in faulty design and in uncritical interpretation of the data obtained. The importance of so planning an experiment that the results are capable of only one interpretation is obvious, but the difficulty of securing this end in even the simplest type of experiment is greater than is commonly recognized. The simpler the plan of an agricultural experiment the better, and yet over-elaboration of the experimental scheme has always been a common failing and still persists. It arises from the natural desire to obtain as much information as possible in the minimum of time with the experimental facilities available—facilities which might be adequate for the attack of one simple problem were the experimenter only content with this, but which only results in failure when sub-divided for the simultaneous attack on several problems.

The history of manurial experiments teems with examples of mistaken enthusiasm of this character. The experimenter starts with a simple scheme of, say, five plots to test the effects of four different combinations of nitrogen, phosphate and potash. The fatal facility of cross-dressing than tempts him to elaborate his scheme by subdividing his basic plots transversely and applying different cross-dressings on the various sections. One cross-dressing gives him 10 plots, a second 15, a third 20, and so on—all sheer futility so long as he has only one plot of a kind. If his resources and energy have enabled him to deal with 20 plots, how much better it would have been for him, instead of trying to test 19 points at once, simply to have quadruplicated his original five plot scheme on the area with plots one-quarter the original size! Then he would at least have secured results of assessable reliability on the original four issues he set out to investigate, and have thereby made a definite contribution to knowledge. With the procedure adopted, however, every one of his 19 comparisons is valueless because he cannot assess the reliability of his results, even to the extent of guaranteeing that the plus differences do actually represent beneficial effects, or the minus differences detrimental effects, of the treatments compared. At most he may perhaps claim that, assuming his conditions of uniformity of soil, etc., to have been average, differences of the order of 15 to 20 per cent. between plot yields are probably significant, but his assumption is purely speculative.

The "single plot" experiment should now-a-days be relegated to the function of qualitative demonstration of points already established by more precise forms of experiment, and if no weighings of crops are taken the temptation to use them is effectively avoided. It is only when the "single plot" experiment forms one of a series carried out on a uniform plan at different centres that the recording of quantitative results may be justifiable, and even then the greatest caution is necessary in drawing conclusions from the whole series of results obtained at the different

centres. The averaging of results in such co-operative tests is inadmissible and usually pointless, and it is rarely possible to do more than compare the general trend of the results at the various centres. The average crop on Plot A at ten centres may be actually less than that on Plot B, and yet if, as may well happen, Plot A is found to have stood first in order of merit at seven out of the ten centres, the intrinsic superiority of the treatment applied to this plot can hardly be questioned.

Even in co-operative work of this character, however, it is desirable that each plot shall be at least duplicated at every centre, in order that some guidance may be available as to the validity of the results before they are embodied in the general comparison. If the results of "single plot" tests are valueless in themselves, it is obviously worse than futile to use them as the basis of further computations such as costs, feeding values, etc., and no criticism of excursions in this direction can be too strong.

To sum up, whilst we have stressed the difficulties of the experimental method and the defects of much of the work in which it has been applied, this in no way affects the fundamental value of the method and its usefulness for the solution of a wide range of practical problems. Provided the experiment be so planned as to measure the effect studied with the degree of accuracy essential for practical purposes, and the interpretation of the results be confined within their range of validity, we can conceive of no other method of attack on practical problems which can give as reliable guidance to the individual farmer.

IMPERIAL AGRICULTURAL BUREAUX.*

BY

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The system of Imperial Bureaux for the centralization and distribution of information on agricultural subjects (among others) has recently received considerable expansion as a result of the recommendations of the Imperial Agricultural Research Conference, 1927. It is the purpose of this article to trace the steps which have led to the present stage of development and to describe the new organization.

The Bureau of Hygiene and Tropical Diseases.

Imperial Bureaux of use to agriculture had their origin in action taken by the Colonial Office in 1908 and 1909. In 1908 that department established the Sleeping Sickness Bureau for the collection and dissemination of information respecting African Sleeping Sickness to medical officers in the Colonies and Dependencies concerned and to investigators engaged in research. In 1912, the scope of this Bureau was widened to embrace all diseases in the tropics both of men and of domestic animals, and it became the Tropical Diseases Bureau. A further development took place in 1926 when, with the publication by the Bureau of a new bulletin of hygiene, its name was changed to the Bureau of Hygiene and Tropical Diseases. The main function of the Bureau as regards tropical diseases is to collect from every possible source information concerning their progress, recognition, prevention and treatment; to collate, condense and where necessary translate this information and to render it accessible to investigators, and to medical and veterinary officers in the tropics with as little delay as possible. The three serial publications of the Bureau are the *Bulletin of Hygiene*, the *Tropical Diseases Bulletin* (both issued monthly) and the *Tropical Veterinary Bulletin* (issued quarterly). The two former are concerned chiefly with man, but deal fully with those diseases that are shared by man and his domestic animals; the *Tropical Veterinary Bulletin* concerns itself entirely with veterinary science. It is intended that this last-named Bulletin shall be taken over in due course by the newly established Bureau of Animal Health (*see* below). Apart from these publications, the Bureau has a valuable library which is open to medical men and others who come to this country from other parts of the Empire. The Bureau is maintained by a grant from Imperial funds and from funds provided by

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Dominion and Colonial Governments; contributions are also received from the Sudan and certain Indian Provincial Governments. The Bureau is under the control of an honorary managing committee appointed by the Secretary of State for the Colonies. It is housed in the premises of the London School of Hygiene and Tropical Medicine.

THE BUREAU OF ENTOMOLOGY.*

The second of the Imperial Bureaux of service to agriculture had its origin the year after the Bureau first described. In 1909, the Colonial Office set up the Entomological Research Committee to further the study of entomology in tropical Africa. In 1913, the scope of the Entomological Research Committee was extended to cover other parts of the Empire, and the Committee was merged into a new Imperial Bureau of Entomology. Contributions are received by the Bureau at the present time from the British Treasury and from practically all the countries of the Empire. The Bureau issues three publications: *The Bulletin of Entomological Research*, containing original articles on economic entomology; *The Review of Applied Entomology*, which reviews all current literature on economic entomology throughout the world and is published in two series (*a*) dealing with insect pests of cultivated plants, and (*b*) dealing with any insects, ticks, etc., conveying disease or otherwise injurious to man and animals; and *The Zoological Record* (section *Insecta*), which contains annually as complete a record as possible of the literature of the previous year, chiefly from the systematic standpoint. In addition to its work of centralizing and distributing information, the Bureau undertakes the identification of insects. Under its aegis, Imperial Entomological Conferences are held from time to time. In 1926, the work of the Bureau was further extended by the establishment from the Empire Marketing Fund of a parasite laboratory for breeding beneficial parasites for export to various parts of the Empire for the control of insects which are injurious to agricultural plants, stock, etc. The parasite laboratory (the parasite " zoo ") is situated at Farnham House, Farnham Royal, Buckinghamshire. The Bureau is administered by an honorary committee of management, the Chairman and Members of which are appointed by the Secretary of State for Dominion Affairs and the Colonies. The head-quarters of the Bureau of Entomology are housed in the Natural History Museum and the Library and Publication Office are at 41, Queen's Gate.

THE BUREAU OF MYCOLOGY.*

The third Imperial Bureau to be formed was the Imperial Bureau of Mycology, which came into being in 1920 following a resolution passed by the Imperial War

* Fuller information regarding the work of the Bureaux of Entomology and Mycology and the Royal Botanic Gardens, Kew, will be found in a volume entitled *Facilities for Advanced Study and Research in Agricultural Science and Cognate Pure Sciences in the United Kingdom*, to be obtained, price 1*s*. net, post free, from the Ministry of Agriculture, 10, Whitehall Place, London, S. W. 1.

Conference in 1918. The funds of the Bureau are obtained from contributions by the Dominions, India, the Sudan, Iraq, and most of the Colonial Dependencies. The British Government does not make any direct financial contribution, but by arrangement with the Ministry of Agriculture and Fisheries the Bureau at present occupies a Government building at Kew, rent free. A new and more commodious building for housing the Bureau is in course of erection near the Herbarium at Kew, part of the cost of which is being met by a grant from the Empire Marketing Fund. For the purpose of dissemination of information, the Imperial Bureau of Mycology publishes *The Review of Applied Mycology*, which gives a monthly survey of all current literature dealing with phytopathology and economic mycology from every part of the world. The Bureau arranges periodical Imperial Mycological Conferences; it undertakes the identification and study of fungous and bacterial plant pathogens; and it maintains a museum of tropical plant diseases, and a lending library for the use of overseas mycologists. Like the Imperial Bureau of Entomology, it is administered by an honorary committee of management appointed by the Secretary of State for Dominion Affairs and the Colonies.

Royal Botanic Gardens, Kew.*

Kew fulfils the functions of a Bureau of Botany in all its aspects. On the economic side it has for many years been actively engaged in obtaining from all parts of the world plants of potential economic value, and in the propagation and distribution of these for experimental cultivation in the Dominions and Colonies. Funds have recently been placed at the disposal of the Ministry of Agriculture by the Empire Marketing Board to enable Kew officers to visit overseas parts of the Empire to advise the Governments concerned on botanical and agricultural problems. A botanical survey of the Empire, the fundamental basis for the development and exploitation of the natural vegetable resources, has been continuously in progress for upwards of three-quarters of a century.

The Government of India, the Union of South Africa and the West African Colonies maintain officers at Kew for the study of the botanical problems of these particular areas, and negotiations are in progress for the interchange of scientific staff between Kew and other parts of the Empire.

Imperial Institute.

The operations of the Imperial Institute must also receive mention. It carries out valuable work (*a*) by investigating Empire raw materials (plant, animal and mineral) in order to determine their possible uses and value; and (*b*) by

* See footnote on previous page.

supplying technical and commercial information relating to such materials. Special Advisory Councils and Committees have been appointed to deal with plant and animal products and with minerals. The Institute publishes a Bulletin which records progress in agricultural, mineral and other industries, with special reference to the utilization of the raw materials of the Dominions, Colonies and India ; it also issues handbooks and other publications on specific products.

THE EIGHT NEW BUREAUX.

The question of the extension of the system of Imperial Bureaux was raised at the Imperial Conference of 1926. The Research Special Sub-Committee of that Conference, in referring to the great value of the work of the existing Imperial Bureaux, suggested that further Bureaux of a similar kind might well be established in other sciences, as the need for them is realized and the constituent parts of the Empire agree to their establishment. Again, the Committee on Agricultural Research and Administration in the non-self-governing Colonies, which reported in 1927, thought that the establishment of special Bureaux for plant breeding and soils on lines similar to existing Bureaux would be of great value. As a result of these recommendations, the question of the development of the system of Bureaux was made one of the principal items for discussion at the Imperial Agricultural Research Conference in 1927. That Conference recommended the establishment of three further institutions with the title of Imperial Bureaux for Soil Science, Animal Nutrition and Animal Health ; and five further institutions on a smaller scale with the title "Correspondence Centres" to deal with animal genetics, agricultural parasitology, plant genetics (crops and herbage plants) and fruit production ; and it also recommended the Centres at which these institutions, with the exception of the Imperial Bureau of Animal Health, should be placed. The Conference considered that the functions of an Imperial Bureau or Correspondence Centre should be to collect, collate and disseminate information of a scientific and technical character ; to reply to inquiries on scientific and technical problems from agricultural departments and scientific workers in any part of the Empire ; and particularly to facilitate intercourse among groups of workers on closely allied problems. On the other hand, it was not considered that the establishment of additional laboratories for attacking imperial problems should form part of the Bureaux organization.

As regards the administration of these new Clearing Stations, it was recommended that funds contributed for the purpose from the various countries of the Empire should be administered by an authority representative of the contributing Governments. Further, it was recommended that each Bureau should be advised by a technical committee of experts including overseas experts (nominated by the Governments concerned), which should report to the financial supervisory body for the Bureaux.

As a result of these recommendations representatives of the interested Governments met in November, 1928, and drew up a scheme for the establishment of the new Clearing Stations of information, the scheme dealing with the functions and funds of the Centres, the administration of the scheme, the number and location of the Centres, their staffing, accounts, etc., and the rendering of technical advice on the conduct of the Centres by specialists in different parts of the Empire. The recommendations of the Imperial Agricultural Research Conference, 1927, as regards the number and location of the Centres, were confirmed, the Bureau for Animal Health (the location of which was left undecided by the Conference) being placed at the Veterinary Research Laboratory of the Ministry of Agriculture at Weybridge. It was, however, decided to make no distinction in title between the Centres and all the new Centres were designated Imperial Bureaux. These new Bureaux and their location are accordingly as follows :—

Names	Location
The Imperial Bureau of—	Attached to the—
(1) Soil Science	Rothamsted Experimental Station, Harpenden, Herts, England.
(2) Animal Nutrition	Rowett Research Institute, Bucksburn, Aberdeen, Scotland.
(3) Animal Health	Veterinary Research Laboratory, Weybridge, Surrey, England.
(4) Animal Genetics	Animal Breeding Research Department, Edinburgh University, Scotland.
(5) Agricultural Parasitology	Institute of Agricultural Parasitology, Near St. Albans, England.
(6) Plant Genetics	Plant Breeding Institute, Cambridge University, England.
For crops other than herbage plants	
(7) Plant Genetics	Welsh Plant Breeding Station, Aberystwyth, Wales.
For herbage plants	
(8) Fruit Production	East Malling Research Station, East Malling, Kent, England.

While all were described as Bureaux, however, it was decided to organize the first three Bureaux above for the present on a larger scale than the remaining five. The purposes of Imperial Agricultural Bureaux were defined as follows :—" To act as effective Clearing Houses for the interchange of information of value to research workers in agricultural science throughout the various parts of the Empire, and for this purpose they should maintain an index of research being carried out in different parts of the Empire and as far as practicable in foreign countries ; they should begin by collecting, abstracting and collating information from all sources bearing on the most important problems under investigation in different parts of the

Empire; they should keep themselves informed of the general progress of research work within their respective provinces in different parts of the Empire; and they should in appropriate cases summarize available statistics where these are of importance in connexion with their work."

As regards the distribution of information it was laid down that Bureaux should on request supply information within the scope of their work to officials and advisory officers in all parts of the Empire, and should on request also, where possible, supply information to research workers in the Empire, such information to include bibliographies and photo-stat prints of articles on specific problems. As regards the general distribution of information it was recognized that special monographs would have to be published from time to time and that it might ultimately be found desirable to establish a journal when a Bureau had become fully established. The recommendation of the Imperial Agricultural Research Conference, 1927, that a Bureau should not undertake any laboratory or field work involving expense was confirmed, but it was realized that a Bureau would be in a position to be of service to research workers in various other ways and especially by facilitating exchange of workers and meetings of workers interested in the same problems in different parts of the Empire, and the exchange of experimental materials for research purposes; and by supplying information on the best centres for post-graduate study, the best sources of supply of apparatus or equipment, etc.

Funds for the New Bureaux.

An agreement was reached as to the contributions of the Governments of the Empire towards the cost of the new Bureaux.

Executive Council.

As a result of the decisions of the meeting, an Executive Council for the administration of the new Imperial Agricultural Bureaux has been appointed by the Governments of the Empire on the general lines suggested by the Imperial Agricultural Research Conference, 1927. The Council controls the fund for the Bureaux, and its distribution among them, and supervises generally the work of the Bureaux. The Chairman of this Executive Council is Sir Robert Greig, of the Department of Agriculture for Scotland, and the Vice-Chairman is Mr. F. L. McDougall, of Australia House.

Officers of the New Bureaux.

The head of the Research Institute to which a Bureau is attached has been constituted in each case *ex-officio* Director of the Imperial Bureau, and in the case of each Bureau there will be at least one whole-time officer, paid from the Council's funds, who will be the Deputy Director or the Chief Assistant for Bureau work.

Official Correspondents.

In place of the Scheme of the Imperial Agricultural Research Conference, 1927, for Technical Advisory Committees, specialists in the appropriate sciences are to be nominated as official correspondents for each Bureau by the Governments represented on the Executive Council; and in each country the representative of the Bureau will be the official correspondent to whom the Director of the Bureau may turn for such help as he may require and from whom he may obtain suggestions regarding the work and activity of his Bureau. It is expected that these correspondents will take a lively interest in the work and functions of the Bureau and facilitate its activities in the interest of the research workers in the Empire as a whole.

The New Bureaux in Operation.

The scheme outlined above has been accepted by the institutions concerned and has also received wide acceptance from the different Governments of the Empire. Six of the new Bureaux are now functioning and the remaining two will be established shortly.

The writer is indebted to the directors of the older Bureaux, of Kew, and of the Imperial Institute; to the Colonial Office and to the Chairman and Secretary of the Executive Council for the newer Bureaux for suggestions which have been incorporated in this article.

NOTES

A BACTERIAL STALK ROT OF MAIZE.

In August 1928, after heavy rain had fallen, an outbreak of disease was noticed among maize plants grown in the Botanical Area at Pusa.

The disease attacked well grown plants, and was characterized by a rotting of the stalks at about a foot or more from the ground level, accompanied by a putrid smell. As the growing season was nearly over when the disease was noticed, only a few inoculation experiments in the field and in pot culture could be carried out, but these gave good grounds for the belief that the disease was caused by a bacterial infection.

In August 1929, the disease appeared again, and was far more widespread. In all the village lands round Pusa, large numbers of plants were seen to be dying off. Well grown plants in fertile sandy loam fields were attacked, but the low lying *dhab* lands appeared to be free from the disease. The symptoms noticed were the same as those in the previous year.

The disease appears in the stalk, about a foot from the ground ; the stalk loses its green colour and becomes brown, with a water soaked appearance, and easily breakable. Later on the disease may spread to the cob, which then hangs downwards (Plate 1*b*). In the final stage, the stalk breaks, the plant falls to the ground, and the rotting tissues emit a putrid smell.

This disease appears to be the same as one noticed in several States of the United States of America, and described by H. R. Rosen[1] of the Arkansas Agricultural Experiment Station, who showed that disease to be bacterial in origin and gave the name *Phytomonas dissolvens* to the organism responsible.

Not only are the external symptoms identical, but at Pusa the organism isolated in pure culture and found by repeated inoculations, isolations and re-inoculations to cause the disease has the same cultural characters as *Phytomonas dissolvens*.

No preventive or remedial measures for the disease can be recommended ; the outbreaks generally occur during dull, cloudy weather, following heavy rain, and it is only in such weather that artificial inoculations have taken effect.

The organism responsible for the disease is a short, non-motile, non-spore bearing rod about $0{\cdot}7\mu \times 1{\cdot}0\mu$ and a facultative anaerobe. It gives a negative reaction with Gram's stain and is not acid fast.

It produces acid and gas in various carbohydrate media and grows rapidly on nutrient agar. The colonies on nutrient agar plate are white, round, glistening, and opaque. [Hari Har Prasad.]

[1] Rosen, H. R. Bacterial Stalk Rot of Corn. *Arkansas Agri. Expt. Sta. Bull. No. 209.*

Explanation of Plates I and II.

A Bacterial Stalk Rot of Maize.

Plate I. Natural infection.

(*a*) Early stage of disease. Note the browning of stem at the third internode above the adventitious roots.

(*b*) Later stage. Browning of stem has extended, and the cob now bends down.

Plate II. Artificial infection. Young plant. Note the browning and falling over of the stem.

INDIAN RICES IN THE UNITED KINGDOM.

ALTHOUGH the British Empire is the largest exporter of rice in the world, it is a curious fact that the bulk of the rice consumed in the United Kingdom comes from America and Spain. The Empire Marketing Board, therefore, recently launched a campaign for calling attention to the rices of Bengal and Burma. The Board at first appealed to the grocers through the trade papers to " stock and sell Indian rice from Bengal and Burma," emphasizing the fact that ' rice is by nature an Eastern product, and the genuine rices from Bengal and Burma, which are produced under natural conditions, are the best and at the same time the cheapest rices on the market." This was followed by an advertisement in the general press, reaching nearly twenty-five million readers. This advertisement for the housewife was couched in the following persuasive terms :—

" In Bengal and Burma, rice grows in its natural surroundings. The tropical rains flood the paddy fields and the crop is ripened and dried by the Indian sun without the mechanical aids required in Western countries. That is why the genuine rices from Bengal and Burma are of the finest quality and give the best value to the housewife.

" Do not buy your rice solely on appearance. Quality means something more than good looks ; and quality and value for money are the careful housewife's first consideration. Once you have proved the excellence of Indian rice, you will never give it up.

" Ask your grocer for the natural Patna (Bengal) and Burma rices, and taste for yourselves how good rice dishes can be, when every grain is separate, firm and full flavoured."

The Board has also prepared a leaflet on Indian rice for distribution to all applicants post-free ; it will be offered, too, at all exhibitions in which the Board participates. It includes a number of simple and inexpensive recipes in which Indian rice forms the chief ingredient, and gives " some points worth remembering when cooking rice."

WEATHER AND AGRICULTURAL EMPIRE CO-OPERATION.

THE growing movement amongst Empire countries towards co-operation in problems of agricultural research should receive a further impetus from the meetings of the Conference of Empire Meteorologists held in London during the last week in August 1929. The Agricultural Section of the Conference met under the auspices of the Ministry of Agriculture and Fisheries, the Meteorological Office and the Empire Marketing Board. Sir Napier Shaw presided. The discussions, which covered a wide range of subjects, turned chiefly on what kind of weather knowledge could be made most useful to agriculture, and in what directions co-operation between meteorological and agricultural workers throughout the Empire is desirable.

In addition to some 80 representatives from the three home countries, delegates and observers came from all the Dominions, 17 Colonies, India, Hong Kong, the Sudan and Egypt.

The proceedings, which included two days of visits to experimental stations where a practical study is being made of the relation of weather to growing crops, occupied six days.

The discussions dealt with such varied subjects as education and experimental work, the exchange of information, the effect of frost on fruit, the fluctuations in the numbers of wild rodents such as mice, lemmings, rabbits, and certain fur-bearing animals, the effect of weather on the insect and fungous pests of plants and the use of weather knowledge to forecast the yield of crops.

Resolutions were adopted calling for further work on all these problems.

Steps to develop instruction both in pure meteorology and in agricultural meteorology were recommended, the first in the national systems of education throughout the Empire, and the second in the Agricultural Colleges and farm schools. The suggestion was strongly supported that no agricultural experiments should in future be carried on without the details of the accompanying weather being recorded.

The Ministry of Agriculture and Fisheries in London was asked to act as a clearing centre to focus the results of agricultural meteorological research throughout the world and to distribute the information to both agricultural and meteorological workers throughout the Empire.

An important set of recommendations related to the effect of frost and of other factors on the growth and cropping of fruit and its resistance to disease and pests. Fruit surveys throughout the Empire to solve these problems were recommended as well as the testing of the susceptibility of the chief commercial varieties of fruit to frost damage.

The agricultural members of the Conference were very desirous of the "micro-climatic" conditions of their crops and pests being investigated, and the Conference asked meteorologists to assist agriculturists by devising instruments and methods to measure "micro-climatic" conditions within a growing crop for example, or in a heap of dead leaves, or inside a rat run.

Perhaps the most important resolution on pests and diseases of plants was that recommending the prosecution of research into the effect of weather on these pests and diseases so that forecasts of outbreaks could be made and the farmer and the fruit-grower warned in good time. Other resolutions on this subject dealt with the insects and fungous spores present in the upper air and their distribution by the wind, and research into the effect of pressure, light and the colour of insects, on their development, was also advocated.

Lastly, it was recommended that efforts should be made to carry further the work already accomplished for the utilization of weather data in the forecasting of crop yields.

The subject of agricultural meteorology will be further considered at the next Imperial Agricultural Research Conference which is to be held in Australia and New Zealand in 1932.

EXAMINATIONS IN SUGAR MANUFACTURE.

The examinations held annually by the City and Guilds of London Institute in Sugar Manufacture have recently been completed for 1929. Nine candidates entered for Grade I, and eight candidates for the Final Grade. In the former Grade eight candidates, seven from South Africa and one from Kenya, were successful, three passing in the First Class and five in the Second Class. In the Final Grade two candidates from Mauritius and two candidates from South Africa passed, in each case in the Second Class.

The examinations for the current year will be held on Tuesday, May 6th, and entries should be made through the Educational Authorities of the Territory. The fee for candidates outside Great Britain is 6/- for Grade I, and 7/- for the Final Grade.

The Programme of the Institute containing the syllabuses is obtainable from Messrs. Lamley & Co., 1/5, Exhibition Road, London, S.W. 7, Price 4/- including postage.

PRODUCTION OF SUGAR DIRECT FROM CANE DURING THE SEASON 1928-29.

Twenty-four factories making sugar direct from cane worked in India during the season 1928-29 as against twenty-six in the previous season. Ten of these are situated in the Province of Bihar and Orissa, twelve in the United Provinces, one in Bombay and one in Madras. During the season under report, one factory in Bihar was shut down, while two new factories at Basti and Lakshmiganj in the United Provinces started working. A factory in Burma did not work during the season, and the same was the case with a factory in North Madras and one in the Bombay Deccan. It is encouraging to note that progress continues to be made in the improvement of the milling side of the factory.

The production of sugar direct from cane by factories in India totalled 1,851,702 maunds or 68,027 tons during the season 1928-29, as against 1,845,752 maunds or 67,808 tons during the preceding season. There was thus an increase of 5,950 maunds or 219 tons in the output of sugar during the campaign of 1928-29 as against 1927-28.

The table on p. 76 shows the total quantity of cane crushed and sugar made by the factories in (1) Bihar and Orissa, (2) United Provinces and (3) Bombay and Madras Presidencies.

	Bihar and Orissa		United Provinces		Bombay and Madras*		GRAND TOTAL	
	1927-28	1928-29	1927-28	1928-29	1927-28	1928-29	1927-28	1928-29
	md.	md.	md.	md.	md.	md.	md.	md.
Cane crushed . . .	10,070,812	10,041,194	9,163,925	9,920,660	2,173,152	1,579,004	21,407,889	21,540,858
Sugar made . . .	886,272	865,037	740,088	829,871	219,392	156,794	1,845,752	1,851,702
Molasses obtained . .	372,379	377,822	390,928	425,397	84,306	58,957	847,613	862,176
Recovery per cent. . .	8·80	8·61	8·07	8·36	10·09	9·93	8·62	8·59

* Figures for 1927-28 include Burma.

It will be noticed from the table that in the year 1928-29, the supplies of cane available for crushing were larger than in 1927-28 in the United Provinces only. In the white sugar tract this season the percentage of sugar in the cane was lower, which affected the average percentage recovery of sugar in India.

Statistics regarding the production of refined sugar by refineries in India will be collected, collated and published in due course.

I take this opportunity of expressing my thanks to the proprietors and the managing agents for supplying the statistics worked up in this note. [WYNNE SAYER.]

ECONOMIC POSSIBILITIES OF ZIZYPHUS ROTUNDIFOLIA IN THE UNITED PROVINCES.

THE subject of this note is an obnoxious weed, locally known as *Jharberi or Jari* and gowing wild in almost all the parts of the United Provinces of Agra and Oudh. It is entirely cosmopolitan in its habits and habitat and is often looked upon by the poor as their friend. Duthie describes it as follows :—

"A thorny tomentose bush. Branches grey or covered with white epidermis ; branchlets bifarious, flexuose, pilose when young, armed with twin stipular prickles, one straight and slender, the other shorter, bent down and hooked. Leaves ½ in. to 1 in. long, shortly stalked, ovate to orbicular, serrate, dark green and velvety above, pale and densely tomentose beneath. Flowers in axillary short compact cymes : pedicels ¼ in., longer than the peduncles. Petals obovate, with convolute margins. Disk ten-lobed, with a pit opposite each lobe. Ovary two-celled, styles two, united to above the middle. Drupe globose, ⅓ in. in diameter, shining red or black when ripe. Abundant and often gregarious in the dry waste lands of the Doab, also in the ravine tracts in the vicinity of the Jumna and Chambal rivers."

This weed is so very common that it is seen growing everywhere and on every type of soil. When once it has taken root in the cultivated fields, it is very difficult to eradicate it. It flourishes on all kinds of soils but more so on sandy slopes. It even takes a firm hold on *usar* soils where no other weed would grow. It is this habit of the plant and its general utility to the farmer that are to be considered in determining its economic value.

The feeding value of this bush has not been determined so far by physiological chemists. Farmers living in the Jumna ravines, however, know its utility. All farm animals relish this bush when given in finely chopped condition. Eight to 12 lb. are given to a cow or cow-buffalo, and it is said to increase the yield of milk and also the percentage of fat in milk. It is fed to working cattle as well, and the poor cultivator is thus able to maintain them in condition in the dry months of April, May and June, when there is a general scarcity of green fodder. Ten to 12 lb. mixed with *bhusa* is considered a good ration for one working animal. In the months of December, January and February, the cultivators in these parts

run out of stock of grain and mainly depend on the dried pulp as their chief ration, particularly so in years of scarcity.

Dr. Cheema of the Bombay Agricultural Department, after experimenting for a long time, has recommended this bush to be used as stock for budding choice varieties of *Zizyphus jujuba*[1]. This use of the bush, however, seems to be well known in Northern India: nearly all the existing *jujuba* plants in the Fatehpur District have *Zizyphus rotundifolia* as their stock. The ease with which it takes the bud and the dwarf habit of the plant are the chief points in its favour.

There are thousands of acres of barren *usar* land in these provinces, on which grass will hardly grow, but on which *Zizyphus rotundifolia* seems to be thriving inspite of the intensely alkaline nature of the soil. The Jumna and Chambal ravines cover an extensive area which is practically useless, but which abounds in this bush. Some of this land might be converted into rich *Zizyphus vulgaris* gardens and thus become a source of additional income to the zemindars and the cultivators.

Rai Ishwar Sahai Bahadur, member in charge of the extensive estates of the Kayastha Pathsala, Allahabad, has achieved commendable results in this direction. A portion of this estate's land lying in Manti village in the Lucknow District was unproductive *usar*, supporting nothing else but *Zizyphus rotundifolia.* The Rai Bahadur successfully tackled this problem by grafting *Zizyphus vulgaris* on *Zizyphus rotundifolia* stock, and now the same old unprofitable waste land has been converted into a regularly yielding *Zizyphus vulgaris* plantation. The village being near to Lucknow town, the berry finds a ready market, bringing in steady returns.

Patch budding is the general method of propagation in these provinces. The common method in patch budding is to give one vertical and one horizontal cut representing the letter T. But the writer's experience is that in opening out the bark it often splits. In order to avoid this, another horizontal cut should be made at the base: the bark then does not resist and comes off easily. The budding is performed in the following way:—The bush is headed back to the level of the ground in the month of February or March. Four to six vigorously growing shoots sprout up. The two best shoots are selected out of these, and the rest are again headed down. At the commencement of the rainy season these shoots are budded. At the height of a foot or so, a simple vertical cut is given to the stock plant. Then a horizontal cut is given above and another cut is given below. This forms a cut of the shape of I. After these cuts have been given, the bark is separated very conveniently and remains attached to the plant. The selected scion after being cut from the mother plant is kept in sugared milk upto the time it is put in the place rendered open in the stock plant. The flaps are then turned in and the whole is securely bound with sann-hemp fibre or better with Munj grass. A plaster of cow-dung mixed with tank clay is then applied, leaving the bud clear. All shoots which sprout up from time to time near and below the bud from the stock are cut off. When

[1] *Agri. Jour. India,* XXIV, Pt. I, January 1929.

the bud has grown into a sufficiently long shoot, the plant is earthed up in order to give support to it. These budded plants start giving fruit from the next season, and in the course of three years they become capable of yielding the maximum. The fruit is generally harvested from December to the middle of February. In March the plants are pruned. New shoots develop vigorously and bear good fruit. Each plant yields about a maund of berries which is worth about a rupee in the market. [S. MANSINGH.]

The total area planted with sugarcane in Java for the 1930 crop amounts to 198,710 hectares, an increase of 0·8 per cent. over the preceding crop.

Personal Notes, Appointments and Transfers, Meetings and Conferences, etc., etc.

The following names appeared in the New Year's Honours List :—

C. I. E.—MR. B. C. BURT, M.B.E., B.Sc., Agricultural Expert, Imperial Council of Agricultural Research.

Khan Sahib.—MR. MUHAMMAD GHULAM QADIR, Officiating Deputy Superintendent, Civil Veterinary Department, United Provinces.

Khan Sahib.—CHAUDHRI ALI MUHAMMAD, Assistant Professor of Agriculture, Agricultural College, Lyallpur.

Rai Sahib.—MR. KALIDAS SAWHNEY, Cotton Breeder, 'Iraq Government.

Rao Sahib.—MR. G. L. KOTTUR, Cotton Breeder, Southern Mahratta Country, Bombay Presidency.

The services of MR. A. B. REID, I.C.S., temporary Joint Secretary to the Government of India in the Department of Education, Health and Lands, have been replaced at the disposal of the Government of the United Provinces, with effect from 29th November, 1929.

MR. G. S. BAJPAI, C.I.E., C.B.E., I.C.S., has been appointed temporary Joint Secretary to the Government of India in the Department of Education, Health and Lands, with effect from the forenoon of 30th November, 1929.

The services of MR. G. S. HENDERSON, N.D.A., N.D.D., Imperial Agriculturist, have been placed at the disposal of the Government of Bihar and Orissa with effect from 2nd November, 1929, for appointment as Director of Agriculture.

MR. WYNNE SAYER, B.A., Secretary, Sugar Bureau, Pusa, has been appointed to officiate as Imperial Agriculturist, in addition to his own duties.

MR. A. M. MUSTAFA, B.A., Agronomist, Imperial Institute of Agricultural Research, Pusa, has been confirmed in that appointment with effect from 21st June, 1929. On reversion from the N.-W. F. P. Administration to his substantive appointment, MR. MUSTAFA has been granted leave for six months *ex*-India with effect from 5th October, 1929.

Mr. H. Cooper, M.R.C.V.S., Pathologist, has been appointed temporarily as Assistant Director, Imperial Institute of Veterinary Research, Muktesar, with retrospective effect from the forenoon of 12th June, 1929, until further orders.

Rao Bahadur D. Ananda Rao, B.Sc., has been appointed as Headquarters Deputy Director of Agriculture, Madras.

Mr. Govinda Kidavu, Dip. Agri., Deputy Director of Agriculture, Madras, has been placed in charge of the IV Circle, *vice* Rao Bahadur D. Ananda Rao.

Mr. Saadat-ul-lah Khan, M.A., Deputy Director of Agriculture, Madras, has been placed in charge of the VII Circle, *vice* Mr. Govinda Kidavu.

Mr. D. Balakrishnamurti, Dip. Agri., Deputy Director of Agriculture, Madras, has been placed in charge of the II Circle, *vice* Mr. Saadat-ul-lah Khan.

Mr. A. P. Cliff, B.A., Deputy Director of Agriculture, North Bihar Range, has been appointed as a special officer for three months to work out detailed schemes of an Agricultural College for Bihar and Orissa, with effect from 1st January, 1930, or any subsequent date on which he may be able to take up the work. Mr. Beni Madhab Chatterjee has been placed in charge of the North Bihar Range during the absence, on deputation, of Mr. A. P. Cliff, or until further orders.

Mr. D. Hendry, M.C., M.A., B.Sc., Deputy Director of Agriculture, Burma, has been permitted by His Majesty's Secretary of State for India to resign the Indian Agricultural Service with effect from 3rd November, 1929.

The headquarters of Mr. D. T. Mitchell, M.R.C.V.S., Veterinary Research Officer, Burma, has been transferred from Insein to Rangoon with effect from 1st December, 1929.

On the termination of the temporary appointment of Fodder Adviser, Amballa Dn., Khan Bahadur M. Fetehuddin has been appointed Deputy Director of Agriculture, Jullundur, Punjab.

The designation of "Director, Civil Veterinary Department, Punjab," has been changed to "Director, Veterinary Services, Punjab."

MR. J. C. McDOUGALL, M.A., B.Sc., Deputy Director of Agriculture, Southern Circle, Central Provinces, has been granted leave for ten months and 10 days with effect from 16th November, 1929.

The designations of "The Veterinary Adviser to the Government, Central Provinces" and the "The Second Superintendent, Civil Veterinary Department, Central Provinces" have been changed into those of "Director of Veterinary Services, Central Provinces," and "Deputy Director of Veterinary Services, Central Provinces," respectively.

MR. J. H. G. JERROM, M.R.C.V.S., Superintendent, Civil Veterinary Department, Sind and Rajputana, has been granted leave for seven months with effect from 3rd April, 1930. KHAN SAHEB J. D. BUXY will act as Superintendent during MR. JERROM's absence.

NEW BOOKS

On Agriculture and Allied Subjects

1. Laboratory and Field Ecology, by V. E. SHELFORD. (London: Bailliere, Tindal & Cox.) Price, £2-5-0.
2. Productive Sheep Husbandry, by W. C. Coffey, Pp. 480. (London: J. B. Lippincott.) Price, 12*s.* 6*d.* A new edition of Dr. Coffey's well-known text-book on sheep in the United States of America.
3. Report on the Marketing of Cattle and Beef in England and Wales, 1929. (London: H. M. Stationery Office.) Price, 6*d.* net.
4. Plant in relation to Water: A study of the Physiological Basis of Drought Resistance, by N. A. Maximov. Authorized English translation. Edited with Notes by R. H. Yapp. Pp. 451. (London: Allen and Unwin.) Price, 21*s.*

The following publications have been issued by the Imperial Department of Agriculture in India since our last issue :—

Memoirs.

1. Studies in Indian Oil Seeds. No. 3—*Carthamus tinctorius* Linn., by Khan Sahib Abdur Rahman Khan. (Botanical Series, Vol. XVIII, No. 3.) Price, As. 4 or 5*d.*
2. A New Method of dispersing Soils for Mechanical Analysis, by Amarnath Puri, M.Sc., Ph.D., A.I.C. (Chemical Series, Vol. X, No. 8.) Price, As. 5 or 6*d.*

Bulletin.

3. List of Publications on Indian Entomology, 1928. (Compiled by the Imperial Entomologist, Imperial Institute of Agricultural Research, Pusa.) Price, As. 7 or 9*d.*

Report.

4. Report of the Imperial Institute of Veterinary Research, Muktesar, for the year ending 31st March, 1929. Price, Rs. 1-4-0 or 2*s.*

MGIPC—M—III-1-129—17-2-30—2,000.

ORIGINAL ARTICLES.

FIFTEENTH MEETING OF THE BOARD OF AGRICULTURE IN INDIA.

BY

J. H. RITCHIE, M.A., B.Sc.,
Secretary, Indian Central Cotton Committee.

THE Fifteenth Meeting of the Board of Agriculture in India was held at Pusa from the 9th to 13th December, 1929, under the presidentship of Sir T. Vijayaraghavacharya, Vice-Chairman of the Imperial Council of Agricultural Research. There was a good attendance of members who numbered fifty, and in addition fourteen gentlemen were present as visitors. The latter included in their number the Hon'ble Khan Bahadur Sir Saiyad Mohammed Fakhruddin, Minister for Agriculture, Bihar and Orissa, and Sir Frank Noyce, Secretary to the Government of India in the Department of Education, Health and Lands, to both of whom the President extended a special welcome in his opening address.

The President referred briefly to the Report of the Royal Commission on Agriculture and to the formation of the Imperial Council of Agricultural Research. The first meeting of the Imperial Council, he said, recommended that the Board of Agriculture should in future be composed of two wings and designated " The Board of Agriculture and Animal Husbandry," and that all the work in connection with it should be transferred to the Research Council. The two wings would meet in alternate years. The constitution of both wings had been enlarged and would now number 101 in the agricultural and 100 in the animal husbandry wing. The reason for this expansion was due to the demand of Local Governments for facilities for specialist officers and to an increase in the number of unofficial and university members for whom 20 and 5 seats, respectively, had been provided. Continuing, the President referred to the proposed publications of the Research Council. There would be three Journals, of which two would be scientific and the third would be a popular Journal. It was proposed that these should be called the Indian Journal of Veterinary Science, the Indian Journal of Agricultural Science and the Indian Journal of Agriculture and Animal Husbandry respectively. The scientific Journals would be divided into two parts, the first for original articles and the second for abstracts of work done in India and selected abstracts of work done in foreign countries. The Council of Agricultural Research also appointed a Sugar Committee

which had met once and submitted an interim report on the recommendation of which the Council had submitted to the Government of India that the Tariff Board should investigate the question of protection in order to give a fillip to the local industry during the period of agricultural reconstruction. The Council had also recommended that the present *ad valorem* duty on low grade sugar should be changed to a specific duty. A grant of Rs. 6,000 had been given to the Shahjahanpur Agricultural Experiment Station to carry on the work of testing new seedlings. Rs. 8,000 had been allotted to each of the provinces of Bihar and Orissa, the United Provinces and the Punjab for evolving an approved type of small sugar crushing mill, and it had also been decided to offer a prize of Rs. 20,000 to the inventor of the best mill. A substantial grant had also been proposed for the Harcourt Butler Technological Institute in the United Provinces to enable the Section of Sugar Technology to be developed. The Research Council had also appointed a Committee on locusts and had decided to appoint an officer for one year to go into the question of the marketing of hemp. In conclusion, the President said the Council of Agricultural Research had a wide field of usefulness before it. It did not attempt to interfere in any way with Provincial Departments or the control of these departments; all it wished to do was to supplement the efforts of the provinces. The Council's grants were equally open to provincial and imperial institutions, and the Council would supply the co-ordinating link which had been lacking in the past.

After the Hon'ble Sir Mohammed Fakhruddin and Sir Frank Noyce had replied to the references made to them by the President in his opening remarks, the Board appointed Committees to deal with most of the subjects on the agenda.

The Board then proceeded to the consideration of *Subject IV—The desirability of discussing the subject of the best means of bringing improved methods of agriculture to the notice of the cultivators, at future meetings of the Board.*

Messrs. Milne and Vagholkar gave details of the methods employed in the Punjab and Bombay. Mr. Devadhar considered that dramas and coloured pictorial representations of the work of the Agricultural Departments would be more useful than the present methods employed. Sir Frank Noyce said that the evidence given before the Royal Commission on Agriculture showed that there was a great deal of ignorance regarding the propaganda work carried out by the Agricultural Departments, and he thought that if a review of this work were made annually it would help to dispel the idea that nothing was being done. He proposed the following resolution which was adopted unanimously :—

That a review of the organization for all methods of agricultural propaganda and other extension work should find a place in the agenda by both wings of this Board at its future meetings.

The Board then took up *Subject X—To select a place and date for the next Cattle Conference and to discuss the advisability of combining this with Sectional Meetings of officers representing veterinary medicine, animal nutrition and animal genetics.*

The President said that the Council of Agricultural Research had decided that the time and place of the next meeting of the Animal Husbandry wing of the Board

should be fixed by the Chairman of the Advisory Board and that sectional meetings would also be held in connection with the general meeting of the wing. This was accepted.

The Board then proceeded to discuss *Subject VIII—To consider recommendation 27 of Chapter XIV of the Report of the Royal Commission on Agriculture, to make recommendations and suggest suitable problems for economic study.*

Mr. Burt opened the discussion by reading the particular recommendation referred to, which is as follows :- " The establishment of a Bureau of Rural Economic Research in each of the Provinces on lines similar to those on which the Board of Economic Inquiry in the Punjab has been established, would prove of value." These Boards, he said, permit of enquiries being conducted into certain economic problems, and the results should be of great value to all agricultural officers who realized their importance. It was desirable that an agricultural officer should know the full economic significance of any changes in agricultural practice whether they took place naturally or through the efforts of the department. When the Central Cotton Committee carried out its investigations into the marketing and financing of cultivators' cotton, it was first found necessary to ascertain actual facts of village life. The problems to be investigated would not necessarily be the same in the different provinces.

Mr. Milne stated the composition of the Punjab Board, which consisted of 25 members of whom 9 were officials. The Local Government gave the Board a non-lapsing grant of roughly Rs. 50,000 a year which was placed in the Imperial Bank and was entirely at the disposal of the Board. The funds were mainly used to pay the investigators and for the publication of the results. Before starting any enquiry a questionnaire was drawn up by the Board and the aim was to get facts and not opinions.

Mr. Hilson said that this particular recommendation was discussed by the Advisory Committee in Madras which agreed on the necessity of acquiring the information but did not think it necessary to appoint a Board for the purpose. For any enquiry, the appropriate department should appoint the best men to carry out the investigations without the need of having to put the information before a composite Board.

Mr. Burt, after fuller discussion, moved the following resolutions which were unanimously adopted :—

That the Board cordially endorses recommendation 27 of Chapter XIV of the Report of the Royal Commission on Agriculture, and desires to emphasize the need for whole time investigators for economic enquiries as it is impossible for agricultural assistants to carry out these investigations in addition to their ordinary duties.

That the following subjects for economic study be agreed on :—(1) Marketing of crops. (2) The finance of the cultivator with special reference to marketing. (3)The consolidation of holdings. (4) Size of holdings and the number of uneconomic holdings. (5) The cost of production of crops, cattle and dairy produce. (6) The cost of maintenance of cattle. (7) The economics

of a village herd. (8) Co-operation between landlord and tenant in promoting agricultural improvement. (9) The study of overpopulation of land and means whereby excess population could be diverted from the land into other channels.

It was decided to add other subjects to the list as they were brought forward.

The second and third days were devoted to the meetings of the several Committees and to visits to the various Sections of the Pusa Research Institute.

The Board re-assembled on the fourth day and took up the consideration of the Committee reports.

Dr. Coleman introduced the report of the Committee on *Subject IX—To consider the need for mathematical assistance in the study of agricultural genetics and of economic problems and to suggest how this need should be met.* The Committee proposed two resolutions for the consideration of the Board and these, after some discussion, were amended as follows and passed :—

(1) Resolved that the Board of Agriculture considers the establishment of a Statistical Section in the Imperial Agricultural Research Institute, with a statistician of high training in statistical methods as applied to agriculture as its head, a question of urgent importance.

(2) The Board of Agriculture considers that the necessity of providing statistical staff in the various Provincial Departments of Agriculture which has been emphasized by previous Boards in 1919 and 1924 should once more be impressed upon Local Governments. They further consider that the Statistical Sections of Provincial Agricultural Departments should be organized on such a basis as to permit of the inclusion of the statistical treatment of experimental data among their regular duties.

(3) The Board of Agriculture trust that the Imperial Council of Agricultural Research will encourage the greater application of modern statistical methods to agricultural and veterinary problems both in imperial and provincial institutions in such manner as they consider most effective.

The Board then passed on to consider the report of the Committee on *Subject XI—To review the progress made in regard to the protection of crops from the depredations of wild animals since 1925, and to advise whether the recommendations made by the Board of Agriculture in that year require modification in the light of the knowledge and experience now available.*

The findings of this Committee were embodied in the following resolution which, along with a supplementary one proposed by Mr. Afzal Hussain, one of the members of the Committee, was passed unanimously :—

Resolved that the Board of Agriculture draw attention to resolution No. 4 of the 1925 Board of Agriculture recommending that a specially suitable officer should be deputed to study the life-history of the wild pig, and recommend that the scope of the enquiry be extended to include all animals other than insects which do extensive damage to crops. The Board further recommend that a special officer with necessary staff be appointed to investigate the whole question of the protection of crops from the depredations of wild animals.

That the scope of the enquiry should be limited to mammals only.

The Board then considered the Report of the Committee formed to deal with *Subjects I and II* on the agenda, *viz.*, *Subject I—To review the progress made in developing cattle-breeding and to make recommendations on* :—

(i) *the standardization of records which should be maintained at cattle-breeding farms with a view to determine correctly the progress in the improvement of cattle.*

(ii) *The possibilities of organizing the dairy industry on a co-operative basis by the Co-operative Departments in India.*

(iii) *The position of grassland in the improvement of cattle and the possibility of improving such grassland.*

Subject II.—To review the work done up-to-date on animal nutrition in India and to recommend (a) what steps should be taken to develop and extend this work and (b) ways in which the Provincial Departments can best co-operate with the Physiological Chemist in work on this subject.

The report of this Committee took the form of several resolutions which after discussion were amended as follows and passed :—

I. (i) This Board, as a result of evidence placed before the meeting, supports the view that to effect general improvement in the cattle of India attention should be concentrated on the indigenous breeds.

(ii) The question of increasing the milk supply in urban areas is one which can be dealt with separately, and the best means of obtaining th edesired result will depend on local conditions.

(iii) The interesting experiments in cross-breeding with imported stock now being conducted at the Hosur Cattle Farm and at the Allahabad Agricultural Institute under the consideration of the Board may usefully be carried out to their conclusion.

II. That in the opinion of this Board the custom of dedicating bulls as Brahmini bulls without selection militates against the improvement of the cattle of the areas where it prevails ; the Board accordingly suggests to Local Governments that they adopt such measures as may be found feasible to make this custom contribute to the improvement of the cattle.

III. (i) The development of the dairy industry and the improvement of the various breeds of cattle in India are lines of work which are interdependent and complementary ; in regard to the former the Board considers that India like Denmark and Holland being a country of small holdings can best develop her dairy industry on co-operative lines as has already been successfully achieved in Bengal, and to this end recommends that the organization of co-operative societies be undertaken through the agency of Government Co-operative Departments working in conjunction with the Agricultural and Veterinary Departments for the utilization of milk and all its products.

(ii) The Board further considers that facilities for the education of co-operative officers in this particular class of organization and for the training of expert dairy and cattle farm staff to manage co-operative dairies and cattle breeding, be provided.

IV. (i) In view of the importance of grazing areas in connection with the cattle industry, steps should be taken on the lines of those already initiated in the Bombay Presidency to conserve and improve existing grasslands.

(ii) In respect of forest grazing areas the Board recommends that the Forest, Agricultural and Veterinary Departments of provinces and States acting in concert should take suitable measures for their control and better utilization.

V. The Board commends the work on animal nutrition now being done by the Imperial Physiological Chemist to the notice of officers of the Agricultural and Veterinary Departments in the provinces engaged in the administration of cattle farms and on animal nutrition problems with a view to their co-operating with him in conducting as many experiments as possible, and, to enable the Physiological Chemist to undertake these outstation experiments, the Board recommends that the field staff of the Nutrition Station be strengthened as necessity arises and be made available for duty in all parts of India.

VI. That the forms as recommended by the Cattle Committee be adopted by the Board. (*These forms include standard history sheets for male and female stock and records of measurements of breeding bulls.*)

The President then called on Dr. Harrison to introduce the report of the Committee on *Subject XII—To consider the recommendations of the Board of Agriculture, 1919, the report of Messrs. Henderson and Sayer and the opinion expressed by the Pusa Council on November 14th, 1929, and to advise what changes should be made in the existing series of the permanent manurial and rotation experiments of Pusa.*

Dr. Harrison explained that the permanent experiments at Pusa were laid down in 1908 and were continued till 1919 when a special Committee reported on them to the Board. This Committee proposed splitting them into three series, but recommended that the new proposals should not be put into force for one year to allow the Mycologist to complete his observations on wilt in the *rahar* (pigeon-pea) plots. The result ultimately was that the new proposals were not put into effect, but ten years' further results had been added to the original experiments. One thing had been proved, *viz.*, that the manure being given was not sufficient to maintain fertility which had shown a continuous drop. Certain modifications were therefore suggested. His Committee also recommended that barley and wheat should be substituted for oats as being more in keeping with local agricultural practice. They also recommended that standard dressings of potash and phosphate should be applied instead of the quantity being dependent on the amount of farmyard manure. The modified scheme as proposed by the Committee was adopted by the Board and will be put into operation from the next monsoon season.

The Board then dealt with the report of the Committee on *Subject V* whose terms of reference were—*To review the present position of mechanical cultivation in India with special reference to (a) the possibility of extending tractor cultivation and (b) the special kinds of cultivation for which mechanical cultivation is advantageous, and to make suggestions for co-operative action by the various Departments of Agriculture to determine the best type of machine for Indian conditions and for the interchange of information and experience, and to consider recommendation 65 of Chapter IV of the Report*

of the Royal Commission on Agriculture and to make suggestions for investigations into the best method of determining the draught of bullock-drawn implements.

Mr. Henderson, in introducing the report, said that the Committee thought the best way to tackle the subject was to issue a questionnaire, the answers to which had been summarised and would be of great use to the Agricultural Departments and to the trade. The chief trouble with some makes of tractors was with regard to spare parts. Several members gave their experiences with tractors in various parts of India and, after an interesting discussion, the following resolution was accepted unanimously by the Board :—

Resolved that a whole-time expert should be appointed and attached to the Agricultural Expert to the Imperial Council of Agricultural Research who will be available for giving advice to the provinces on problems connected with mechanical cultivation. This expert must possess extensive knowledge of current agricultural machinery, design and manufacturing practices and will act as a co-ordination agency.

Further resolved that he should, in addition to his other duties, take up investigations in connection with the determination of draft of bullock-drawn implements.

The Board then passed on to the consideration of the Report of the Committee on *Subject VI—To recommend measures for the collection and publication of work on soils in India.*

The Board unanimously adopted the following resolution proposed by Mr. Milne, Chairman of the Committee :—

That a Central Bureau of Soil Science under the direction of an experienced Soil Scientist is a matter of urgent importance and should be established as early as possible.

Subject VII was next taken up. The terms of reference were—*To consider the question of accurately measuring the amount of water required for various kinds of crops, especially the more valuable crops, and the period during which waterings should take place to give optimum results and to suggest methods of investigation.*

Mr. Roberts in introducing the report said that the subject was considered fully in 1917 at the Poona meeting of the Board of Agriculture, and the Committee thought it best to review the previous report and see how far present conditions agreed with the recommendations then made. The various Governments in India were investing 60 crores of rupees in works in progress and over 50 crores had already been spent, and it was necessary that something should be done to study the economy and duty of water. He proposed—

That an experimental station or stations to carry out the work enumerated in this report be established.

The resolution was passed unanimously.

On the fifth day the Board dealt with the long and interesting report of the Committee on *Subject III—To discuss the question of investigating the biology of the locust and to make suggestions for control measures.*

Mr. Burt moved the adoption of the Committee's report and said that this subject appeared on the agenda of the Imperial Council of Agricultural Research as well

as on that of the Board of Agriculture, and it would have been better if the Council could have had the advantage of considering the recommendations of the Board of Agriculture. In view of the importance attached to the subject by several Local Governments, the Council had appointed a Committee which would take the Board's recommendations into consideration. The report of the Board's own Committee fell into three sections, namely, intelligence, investigation and control. Every province in India had a permanent organization for dealing with famine. He considered that anti-locust measures should be planned on similar lines. Famine measures dealt not only with relief but included both methods of protection against famine and an intelligence organization to enable relief measures to be promptly organized. He thought the same principles should be adopted to deal with locust invasions. To be effective, anti-locust campaigns must be controlled by a large organization and not left to individuals or to small units. The magnitude of the problem would be evident from the fact that the present visitation was estimated to cause a loss of from 3 to 5 crores in Northern India.

Mr. Burt then dwelt on the necessity for the immediate provision of adequate funds, apparatus and labour at the commencement of an invasion. The organization and money should be available to enable immediate measures to be taken. He considered there should be an emergency fund on the analogy of the Famine Fund.

Mr. Afzal Hussain discussed the necessity for the establishment of an Intelligence Bureau. In the Punjab, they had the assistance of the district revenue staff who reported the first appearance of the pest, the hatching of the eggs and the amount of damage done, but this was entirely a provincial organization. It was necessary to follow the movement of the locusts from one province to another. The latest invasion came from Sind and no information was received about it. A central organization with branches in the provinces was required.

Mr. Richards gave his experience in the United Provinces at the beginning of the present invasion, and said that provincial organizations would be of little use unless there was a central one. The main function of a Central Bureau would be to collect information from all over India and to issue warnings similar to the storm warnings sent out by the Meteorological Department.

Continuing, Mr. Richards said that of the problems requiring solution, the most urgent were control methods, of which they had very little experience in India. It was necessary to find out the most effective and cheapest methods of control whether by chemical or mechanical means. Then it was necessary to examine the question whether there are permanent breeding grounds in India. If so, it would be possible to nip an incipient outbreak in the bud. All this work could best be done by the staff controlled by the Central Bureau. He also thought that an effort should be made to cut down expenses as far as possible, and he proposed that stocks of the materials necessary for locust campaigns should be held by the Central Government and provinces could indent on them when required.

Mr. Fletcher dwelt on the need for India to co-operate with the Committee of Civil Research of the Privy Council in an Empire anti-locust investigation. India was only one end of the region of occurrence. There appeared to be a common impulse of increase, and it was more than a coincidence that when outbreaks occurred in India there had generally been outbreaks elsewhere. It was most important that the exact cause should be known. The Committee of Civil Research proposed to employ two pairs of Entomologists and send them to Kenya and the Sudan. India should take the opportunity of co-operating in this investigation and should contribute its quota to the scheme.

Dr. Burns spoke on the necessity of having an organization all ready to be called up in an emergency. The Punjab had such an organization and the United Provinces also to some extent, but in Bombay and Sind it had still to be formed and he considered this should be arranged for at once.

The following resolutions proposed in the report of the Committee were passed unanimously :—

(1) Resolved that immediate steps should be taken for the establishment of an Intelligence Bureau.

(2) The Board of Agriculture recommends that fullest advantage should be taken by India of the present opportunity of co-operating with the Committee of Civil Research in an Empire anti-locust investigation.

(3) The Board of Agriculture desires to emphasize the importance of securing the necessary staff at once to carry out (*a*) investigations on control measures, (*b*) a survey of permanent breeding grounds of the desert locust in India, and subsequently the further investigation into the bionomics of the insect referred to in the Committee's report.

(4) Resolved that since the aim of locust control operations should be the complete eradication of the pest from the whole of the affected area within a single generation, and since inadequate or delayed expenditure may entirely vitiate the success of the operations, it is essential to locust control that there should be an immediate adequate provision for funds, apparatus and labour.

(5) Resolved that an adequate organization for locust control is essential in each province or State within the area subject to locust visitations. The organization adopted in the United Provinces (*vide* Chapter 2 of memorandum by Mr. Richards which forms an appendix to the Committee's report) for dealing with the 1929 visitation and that described in the Land Administration Manual of the Punjab is commended to the notice of all Local Governments and the Government of India. Though details must necessarily differ in the various provinces and States, the anti-locust organization should include :—

(*a*) an adequate intelligence branch,
(*b*) an executive for each district or other administrative unit, and
(*c*) a central controlling authority.

(6) Resolved that the Central Government should carry an adequate store of material for anti-locust campaigns for issue to provinces or States as required.

In dissolving the Board, the President said he was sure he was expressing the views of all members in thanking the authorities at Pusa for their collective official kindness and for individual kindness. There could be no doubt, he said, that these meetings were very useful, even if nothing else were achieved, in bringing together agricultural, veterinary and animal husbandry officers and giving them an opportunity of discussing problems in which they were interested. He thanked the members for their efforts in making the meeting a success.

Dr. Burns, in moving a vote of thanks to the Chair, on behalf of the Board, said the success of the meeting was due mainly to the ability with which the Chairman had conducted the deliberations of the Board.

THE CHARACTERS OF THE COTTON BOLL IN RELATION TO ITS FLOWERING PERIOD AND POSITION ON THE PLANT.*

BY

S. N. VENKATARAMANAN, B.A., B.Sc. (Ag.),

Assistant in Cotton, Agricultural Research Institute, Coimbatore.

Introduction.

It has been the common experience of breeders in cotton that bolls vary widely in character within the same plant. The causes leading to this are many and various. The period of development of bolls extends well over four months, during which wide seasonal changes of rainfall, temperature, light and shade occur. Such variations will have their attendant influence on the boll. A very common observation is the large difference in the maturing period of bolls noted at different times by all workers. A corresponding effect on other boll characters is also likely to occur. Besides, more bolls develop on the point at certain stages of its growth than at others, and this is also a factor to be considered. To evaluate, therefore, the changes in boll character within the plant requires the consideration of many complex factors within and without it. A certain phase of the problem has been presented here by a study of bolls in relation to their dates of flower opening and their position on the plant. These two factors have been chosen with a view to find out how bolls change in character during the season.

Material.

The plants examined were selected from a pure line, Strain No. 54 of Uppam cotton (G. *herbaceum* Linn., Gammie), grown during the seasons 1925-26 and 1926-27 at Coimbatore. The plants were spaced uniformly 2 feet apart in lines 3 feet apart. To ensure normal growth in the plants, only plants not attacked by the shoot borer

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* Paper read at the Indian Science Congress, Madras, January 1929.

(*Earias* sp.) were selected for observation as late as possible before flowering began; while plants attacked later were also rejected from the data. There were 40 plants and 1,860 bolls available for study in the first year and 15 plants and 390 bolls in the second year. It may be said at the outset that so far as the conclusions drawn in this paper are concerned the results of both years are in general agreement. The figures for these have been presented side by side in the tables for comparison.

METHOD OF EXAMINATION.

Flowers were marked and labelled daily and numbered serially on each plant. The position of each flower was separately entered as it occurred on the plant, a method of numeric symbols being used in the denomination of each position. It was found possible by this method to represent all the naturally occurring positions in a normal plant, the position of a later occurring flower being easily determinable from an earlier flower nearest to it and of already known position. The figures from these 'positions' record were afterwards converted into a diagram for each plant in the form shown in Fig. 1 (Hilson)[1] where the numbers represent the serial numbers of the flowers as they opened on the plant.

Bolls were picked daily and separately kept. At the end of the season each boll was individually examined for the following characters:—

1. *Maturation period* (*days*). Time between flowering and picking dates.
2. *Lint length* (*mm.*). Average of three combed seeds one from the middle and one from either end of the locks and distributed in the three locks.†
3. *Lint weight* (*mg. per seed*). Average of lint from all available *kapas*.
4. *Seed weight* (*mg. per seed*). Average of all available good seeds.
5. *Ovules per lock*. Average of all locks.
6. *Seeds per lock*. Average of all locks.

Each of these characters was then studied in relation to the flowering date and the position of the boll examined.

[1] Hilson, G. R.; Ramanath Ayyar, V.; Chockalingam Pillai, R. Bud and Boll Shedding in Cotton. *Pusa Bulletin No.* 156 (1925).

†Although it was recognized that the end seed in a lock was more variable than the rest and that a more uniform sampling could be got from the middle seeds, this method was adopted as giving a nearer approach to the mean of boll—a condition which has been verified by actual observations.

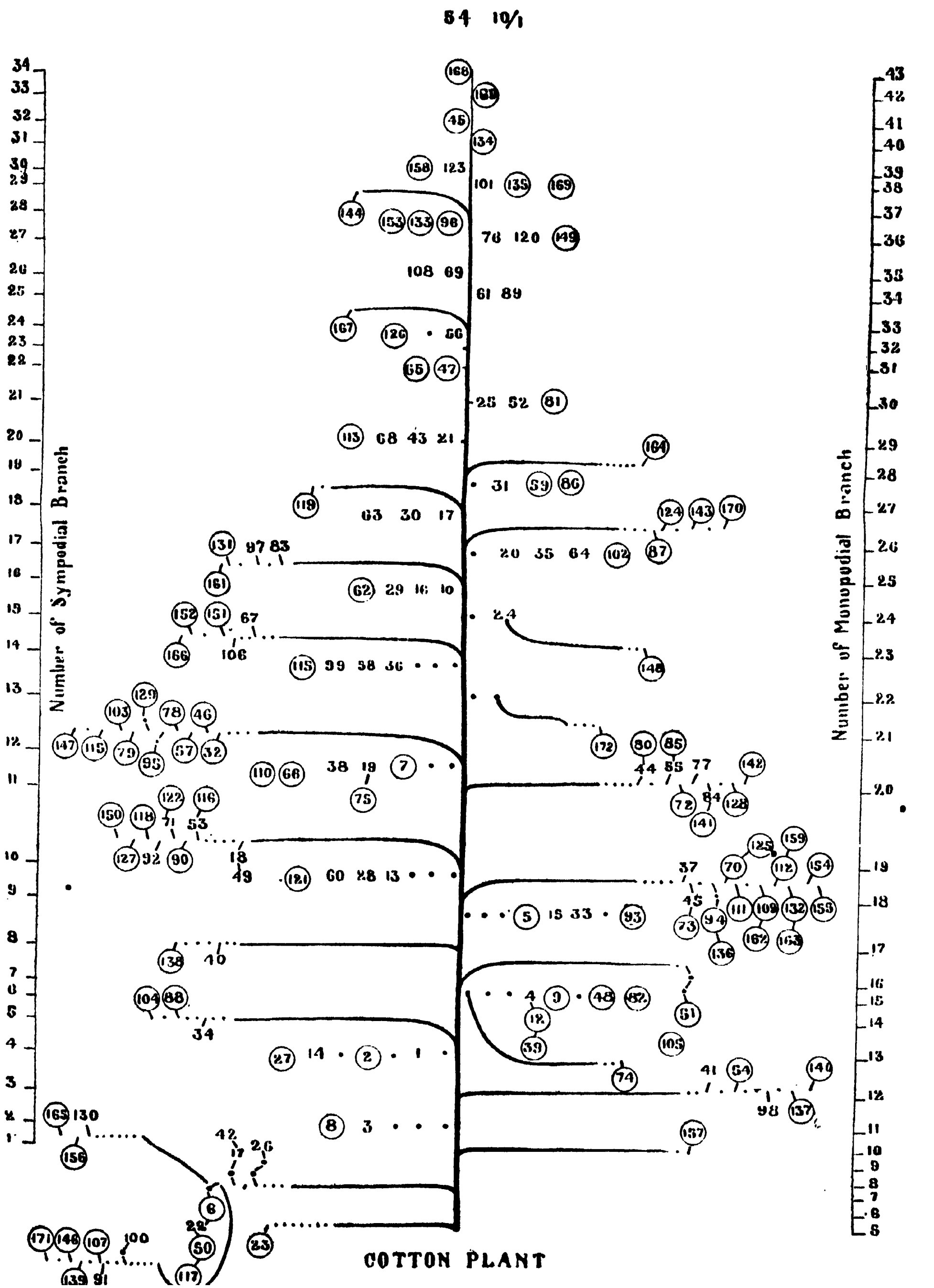

Fig. 1. (Note: Numbers in circles refer to shed bolls.)

VARIATIONS DUE TO THE PERIOD OF FLOWERING.

A very wide variation is found to exist in the characters of bolls from flowers formed at different times. The extent of such variations can be easily understood by a reference to Fig. 2 where the means for each boll character are represented

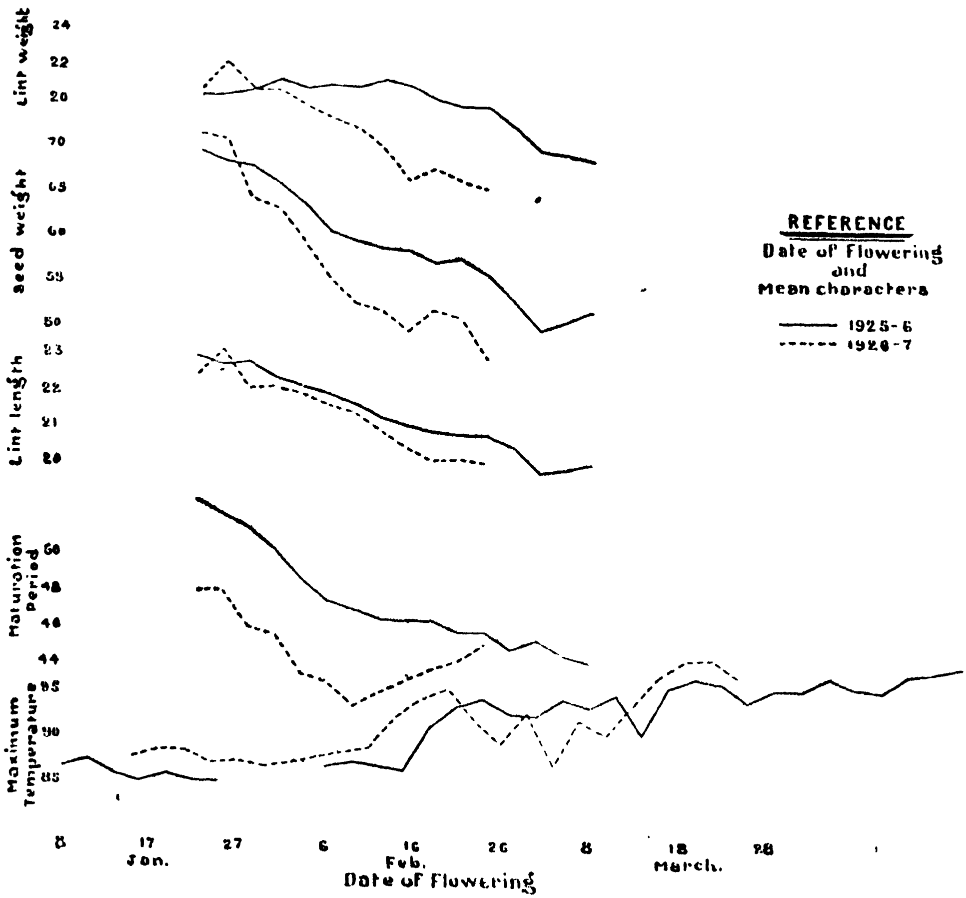

Fig. 2.

for three-day intervals in the flowering period. The slope of the curves indicates a general fall in the maturation period, seed weight, lint length and lint weight towards the later formed bolls. The actual difference between bolls picked at the beginning and the end of the season is very great, the difference between the

highest and lowest values in the same season ranging so high as from 14 to 45 per cent. of the mean of each character as given below :—

TABLE I.

Variation in the characters due to the flowering period.

Character	Year	THREE DAY MEAN VALUES			Difference percentage of the mean
		Maximum	Minimum	Difference	
Maturation period . . .	1925-26 .	53·1 days	44·3 days	8·7 days	18·9
	1926-27 .	48·1 „	42·0 „	6·1 „	13·8
Seed weight	1925-26 .	69·7 mg. per seed	51·5 mg.	18·2 mg.	31·0
	1926-27 .	71·6 „	46·7 „	24·9 „	44·8
Lint weight	1925-26 .	21·2 „	16·7 „	4·5 „	22·4
	1926-27 .	22·2 „	15·1 „	7·1 „	39·5
Lint length	1925-26 .	23·0 mm.	20·0 mm.	3·0 mm.	15·0
	1926-27 .	23·2 „	20·1 „	3·2 „	15·1

It should be mentioned, however, that the decline varies in different periods of the same season and differently with the characters. The rate of decline does not follow any regular course. The fall is generally positive and most pronouncedly so in seed weight and lint length of both years : in lint weight of the first year it occurs later than in the other characters. A slight recovery in the maturation period is also observable in the second year of study. The rate of fall in the characters seed weight, lint weight and lint length is much greater in the second year than in the first. The general tendency to decline towards the later formed bolls is a special feature to be noted in the cotton under study.

This effect of the period of flowering on the boll has been quantitatively determined from correlations between the periods of flower opening and the characters

of the bolls developing therefrom. The correlation coefficients for these characters are given below :—

TABLE II.

Correlation coefficient between the dates of flower opening and the characters of the boll.

	Characters	Year	Correlation coefficient r12, etc.	Partial correlation coefficients r 12·345, etc.
Date of flowering (1) and .	Lint length (2) .	1925-26	—0·523 ± ·017	—0·282 ± ·027
		1926-27	—0·608 ± ·032	
	Seed weight (3). .	1925-26	—0·556 ± ·016	—0·178 ± ·023
		1926-27	—0·698 ± ·026	
	Lint weight (4) .	1925-26	—0·330 ± ·029	—0·029 ± ·023
		1926-27	—0·569 ± ·034	
	Maturation period (5)	1925-26	—0·679 ± ·013	—0·600 ± ·015
		1926-27	—0·441 ± ·041	

The correlations are negative and significant in every case. The regressions, however, are not quite linear and exceed the limit of significance Z, fixed by Fisher's method.[1] The bulk of the variations, however, is accounted for by linear regression. The conclusion is, therefore, justifiable that the characters decline from day to day as the season advances, but the rate of decline varies with different flowering periods.

SPINNING VALUE OF COTTON PICKED AT DIFFERENT DATES.

A similar effect on the spinning value of cotton was also noted in the season. The bulk pickings from a particular field, made during the second week of March and the fourth week of April 1928, respectively, were sent to the Indian Central Cotton Committee Technological Laboratory for spinning tests. Dr. Turner's report shows that the yarns differed considerably in strength, that from the earlier picked cotton being " decidedly superior " to that from the later picking. " This superiority was very surprising in view of the similarity of the fibre properties of

[1] Fisher, R. A. *Statistical Methods for Research Workers*, pp. 212-218.

the two samples." The two samples were adjudged suitable for the following highest standard warp counts.—

	Highest standard warp counts	Value above or below contract rate
		Rs.
Uppam strain No. 615, picked March 2nd week . . .	20's	60 on.
Ditto picked April 4th week . . .	14's	30 on.

The earlier picked cotton is thus seen to have a better spinning value, in addition to the superiority in characters above noted.

Variations due to branching.

In addition to the effect of the flowering period, the character of the boll is also determined by the nature of the sympodial branch, whether primary or secondary. A comparison of these two types of branching showed that the boll on the primary sympodial branch took a longer time to mature, and was better in seed weight, lint weight and lint length than the boll on the secondary branches* (Table III).

TABLE III.

Comparison of bolls from primary and secondary sympodia.

Year		Mean values		Difference	S. E. D.
		Primary	Secondary		
Seed weight . .	1925-26 .	60·986 ± 0·210	57·087 ± 0·164	3·899 mg.	0·263
	1926-27 .	57·569 ± 0·630	52·343 ± 0·633	5·226 ,,	0·893
Lint weight . .	1925-26 .	21·001 ± 0·069	19·436 ± 0·057	1·565 ,,	0·089
	1926-27 .	18·644 ± 0·239	16·907 ± 0·264	1·737 ,,	0·356
Lint length . .	1925-26 .	21·564 ± 0·033	21·076 ± 0·027	0·488 mm.	0·042
	1926-27 .	21·342 ± 0·090	20·927 ± 0·098	0·415 ,,	0·133
Maturation period .	1925-26 .	47·987 ± 0·075	46·412 ± 0·058	1·575 days	0·094
	1926-27 .	44·439 ± 0·191	43·578 ± 0·162	0·861 ,,	0·250

* In this paper the terms primary and secondary sympodia refer to sympodia arising from the main stem and to those arising from the monopodials of the main stem respectively.

This difference in behaviour can be accounted for by the fact that the flowering curve of the primary sympodia is earlier than that of the secondary ones, the actual difference in the mean flowering time between them in the two years being respectively 6·35 ± 0·22 and 3·67 ± 0·86 days. To ascertain how far this is the case, comparisons were made between bolls of these branches from flowers formed at the same time, thus eliminating that factor. The results are given below :—

TABLE IV (*a*).

Comparison between mean values of bolls from primary and secondary sympodia from flowers produced at the same time.

1925-26.

Period of flowering week ending—	LINT LENGTH		SEED WEIGHT		LINT WEIGHT		MATURATION PERIOD	
	Secondary	Primary	Secondary	Primary	Secondary	Primary	Secondary	Primary
January 25th .	23·10 ± ·27	22·70 ± ·10	67·40 ± 1·02	69·68 ± ·66	18·70 ± ·42	21·02 ± ·31	53·20 ± ·37	53·02 ± ·16
February 1st .	22·65 ± ·15	22·[illegible]4 ± ·09	65·87 ± ·87	67·04 ± ·49	19·74 ± ·27	29·88 ± ·20	51·10 ± ·21	50·87 ± ·11
Do. 8th .	21·93 ± ·05	21·92 ± ·05	60·65 ± ·36	62·66 ± ·29	20·26 ± ·11	21·34 ± ·12	47·87 ± ·10	48·04 ± ·08
Do. 15th .	21·38 ± ·05	21·32 ± ·06	58·22 ± ·29	59·28 ± ·39	20·40 ± ·11	21·57 ± ·15	46·52 ± ·10	46·84 ± ·11
Do. 22nd .	20·88 ± ·05	20·89 ± ·07	57·44 ± ·28	58·61 ± ·38	19·71 ± ·11	20·85 ± ·14	46·27 ± ·09	46·24 ± ·11
March 1st .	20·59 ± ·05	20·52 ± ·08	53·67 ± ·31	54·32 ± ·48	18·69 ± ·11	19·64 ± ·17	45·40 ± ·08	45·26 ± ·11
Do. 8th .	19·72 ± ·09	19·74 ± ·12	50·63 ± ·51	49·61 ± ·75	16·88 ± ·16	17·94 ± ·38	45·17 ± ·18	45·32 ± ·25
Difference in favour of primary sympodia.	—·074 ± ·056		1·05 ± 0·37		1·26 ± 0·21		·01 ± ·08	
Odds by Student's method[1].	6·5 : 1 against		434 : 1		5,000 : 1		2·5 : 1	

[1] Love, H. H. Modification of Student's Tables. *J. S. A.*, Vol. XVI, p. 68.

TABLE IV (*b*).

1926-27.

Flowering period	Lint length		Seed weight		Lint weight		Maturation period	
	Primary	Secondary	Primary	Secondary	Primary	Secondary	Primary	Secondary
February—								
2—4	22·25 ± ·23	21·38 ± ·71	60·29 ± 1·40	57·64 ± 1·95	20·25 ± ·62	19·00 ± 1·03	43·95 ± ·47	42·88 ± ·72
5—7	21·79 ± ·38	21·44 ± ·24	56·35 ± 1·03	54·50 ± 1·80	19·42 ± 1·03	18·89 ± ·77	43·84 ± ·40	42·56 ± ·58
8—10	21·44 ± ·15	21·50 ± ·23	54·08 ± 1·26	53·27 ± 1·49	18·78 ± ·65	18·42 ± ·62	42·36 ± ·40	41·42 ± ·43
11—13	21·03 ± ·17	20·82 ± ·19	52·45 ± 1·03	51·07 ± 1·48	17·79 ± ·53	17·00 ± ·54	42·68 ± ·45	42·43 ± ·43
14—16	20·42 ± ·18	20·55 ± ·17	50·52 ± 1·55	49·00 ± 1·44	16·65 ± ·71	14·77 ± ·45	42·35 ± ·49	43·03 ± ·45
17—19	19·80 ± ·27	20·56 ± ·27	51·67 ± ·97	52·47 ± 1·29	16·60 ± ·57	16·18 ± ·61	44·46 ± ·32	43·89 ± ·47
20—22	19·88 ± ·26	20·43 ± ·26	51·94 ± ·89	49·77 ± 1·20	16·39 ± ·73	14·38 ± ·55	44·72 ± ·48	44·08 ± ·75
Mean difference	—·01 ± ·21		1·51 ± ·31		1·03 ± ·26		·58 ± ·25	
Odds in favour of primary sympodia (Student's method).	1 : 2		713 : 1		255 : 1		32 : 1	

The comparisons show that even from flowers opening on the same dates the primary sympodial gives a higher seed and lint weight for the boll than the secondary branch, but not a greater lint length or maturation period. It is, therefore, inferred that a variation occurs between bolls of these branches giving better seed and lint weight in the primary ones, over and above that due to the date of flowering.

The main variations in the cotton plant are thus seen to be twofold—the first being dependent on the period of flowering of the boll, and the second determined by the mode of branching, whether primary or secondary. To trace this twofold influence on the plant, bolls have been studied from position to position along both sympodial and monopodial branches, in the following analysis :—

VARIATIONS FROM POSITION TO POSITION ON THE PLANT.

In this study, a quantitative idea was sought to be obtained of the differences of bolls within the plant from position to position by comparisons between them. The issues involved were classified into the following categories :—

I. **Variation from branch to branch of the main stem**

  (*a*) Between bolls borne on successive sympodial branches.

  (*b*) Between bolls borne on secondary sympodia arising from successive monopodial branches.

II. (*a*) Variation in the bolls produced at successive nodes of each sympodial branch.

(*b*) Variation between bolls produced at the first node of successive sympodia arising from the same monopodial branch.

To study these variations comparisons have been made for each character between one boll and another succeeding it by varying intervals of nodes and branches and from actual values for each position of boll in each plant. The mean difference for each array of comparison is statistically considered for the interpretation of data.

(a) Variation between bolls formed on the different sympodial branches of the main stem.

For this study corresponding bolls of sympodial branches are compared, *i.e.*, the first node of a branch is compared with the first, the second with the second, and so on of another. The results are set forth below :--

TABLE V.

Mean difference between corresponding nodes of sympodial branches on the main stem.

—	—	Branches compared	
		Successive	Alternate
Lint length	1925-26	0·40±0·09	0·45±0·10
	1926-27	0·30±0·13	0·56±0·13
Seed weight	1925-26	2·93±0·43	4·01±0·46
	1926-27	1·04±0·67	3·67±0·76
Lint weight	1925-26	0·47±0·20	0·74±0·34
	1926-27	0·07±0·31	1·32 0·37
Maturation period	1925-26	0·41±0·15	0 81±0·17
	1926-27	0·19±0·25	0·32±0·30
Ovules per lock	1925-26	0·02±0·02	..
Seeds per lock	1925-26	0·05±0·05	..

It will be seen that, except in the case of ovules and seeds per lock, the differences are generally significant. It is therefore concluded that a boll has a significantly higher value than a corresponding one on the succeeding branch in seed

weight, lint length, maturation period and lint weight. In other words, there is a decline in these characters towards the higher fruiting branches.

(*b*) *Variation from node to node in the sympodial branches.*

In this case comparisons have been confined to the nodes in the same sympodial branch with the following results :—

TABLE VI.

Mean difference between one node and its succeeding and alternate nodes in the same sympodial branch.

—	—	Nodes compared	
		Successive	Alternate
Lint length	1925-26	0·88 ± 0·09	1·23 ± 0·20
	1926-27	1·09 ± 0·14	2·20 ± 0·34
Seed weight	1925-26	7·16 ± 0·45	11·35 ± 0·90
	1926-27	9·29 ± 0·91	19·86 ± 2·42
Lint weight	1925-26	1·44 ± 0·26	2·14 ± 0·48
	1926-27	2·63 ± 0·37	4·95 ± 0·68
Maturation period . .	1925-26	1·58 ± 0·16	3·41 ± 0·23
	1926-27	0·81 ± 0·32	3·86 ± 0·90
Ovules per lock	1925-26	0·01 ± 0·02	..
Seeds per lock	1925-26	0·03 ± 0·06	..

A very clear decline is indicated towards the outer nodes in the same characters as above. The magnitude of the difference between successive or alternate sympodial nodes is far higher than that between similarly separated branches, a phenomenon attributable to the fact that the interval of flowering between nodes is much higher in the former case[1].

(*c*) *Variations in the sympodia of monopodial branches.*

For computation of actual differences in this case only first node bolls of monopodial sympodia have been compared as there were not sufficient bolls in the other nodes for comparison.

[1] Harland, S. C. Manurial Experiments with Sea Island Cotton. *West Ind. Bull.*, XVI, pp. 169-202.

TABLE VII.

Mean differences between first node bolls of alternate and di-alternate sympodia in the same monopodial branch, 1925-26.

Character	Sympodial branches compared	
	Alternate	Di-alternate
Lint length	0·61 ±0·10	1·12±0·20
Seed weight	5·36±0·54	10·03±0·92
Lint weight	1·10±0·24	2·28±0·42
Maturation period	0·75±0·21	1·95±0·34

In a similar manner as in the main stem, a perceptible decline occurs within each monopodial branch towards the later sympodia and of about the same magnitude.

(*d*) *Variations in the monopodial branches of the main stem.*

To express the relative values of bolls on successive monopodia on the main stem, comparisons have been made between corresponding nodes of these branches. The results are as follows :—

TABLE VIII.

Mean difference between bolls from corresponding secondary sympodia of monopodial branches on the main stem, 1925-26.

Character	Nature of monopodial branches compared		
	Alternate	Di-alternate	Tri-alternate
Lint length	0·18±0·08 (132 : 1)	0·35±0·08 (10,000 : 1)	0·49±0·09 (10,000 : 1)
Seed weight	0·64±0·43 (10 : 1)	1·75±0·52 (475 : 1)	2·50±0·60 (2,500 : 1)
Lint weight	0·05±0·18 (1 : 1)	0·04±0·20 (1 : 1)	0·22±0·27 (4 : 1)
Maturation period	0·00±0·18 (1 : 1)	0·36±0·22 (15 : 1)	0·66±0·24 (140 : 1)

As the number of comparisons was few, a check on the results was made by Student's method [1], [2] the odds in favour of the difference being represented in brackets below each mean figure. It will be seen that although the differences between alternate branches is significant only in the case of lint length, a further level of comparison gives significant results in the case of seed weight and next in maturation period, but not in lint weight. From the high odds obtained it is inferred that a fall occurs in the magnitude of the characters lint length, seed weight and maturation period upwards in the monopodia of the main stem, but the difference between the two branches becomes significant only after passing a few nodes up the stem.

Relation between the flowering period and height on the plant at which the boll is produced.

The results so far indicate a general decline in the characters from position to position both upwards on the branches of the main stem and outwards on each branch. A similar tendency towards later flowers has already been independently shown to exist. As the flowering and development of bolls occur in succession on the plant, it was sought to investigate how much of the superiority of the earlier positions was due to their earlier flowering period. An indication of the results was obtained by the following method. The first node bolls of fruiting branches of the plants were studied in relation to (1) their flowering period and (2) the height in nodes of the plant at which the boll is produced. The influence of these factors on the boll characters can be understood by the appended correlations.

TABLE IX.

Correlation coefficients of each character with the date of flowering and height in nodes at which the boll is produced on the sympodia.

Subject	1925-26		1926-27	
	Relative		Relative	
	Flowering period (1)	Height in nodes on the plant of boll (2)	Flowering period	Height in nodes on the plant of boll
Seed weight (3)	−·709 ± ·040	−·670 ± ·044	−·832 ± ·031	−·796 ± ·037
Lint weight (4)	−·236 ± ·076	−·207 ± ·077	−·584 ± ·067	−·597 ± ·065
Lint length (5)	−·469 ± ·062	−·571 ± ·054	−·653 ± ·057	−·801 ± ·035
Maturation period (6)	−·680 ± ·043	−·573 ± ·054	−·414 ± ·083	−·450 ± ·079

[1] Love, H. H. Modification of Student's Table. *A. S. A.*, Vol. XVI, p. 68.
[2] Student. The Probable Error of a Mean. *Biometrika*, Vol. VI, p. 1.

It will be seen that within the same year the correlations move together in magnitude and direction. In other words, the influence of positions follows much on the same lines as that of the date of flowering. The inter-dependence of these two factors can be seen by the considerably reduced values of the partial correlations got for the one by elimination of the other and given below.

TABLE X.

Partial correlations of the date of flowering (1) and height in nodes of the boll (2) on the sympodial branch.

Character	Partial correlation	1925-26	1926-27
Seed weight (3)	$r13\cdot2$	—·276 ± ·073	—·444 ± ·080
	$r23\cdot1$	—·159 ± ·077	—·159 ± ·095
Lint weight (4)	$r14\cdot2$	—·117 ± ·078	—·143 ± ·098
	$r24\cdot1$	—·006 ± ·079	—·209 ± ·096
Lint length (5)	$r15\cdot2$	—·041 ± ·079	—·227 ± ·095
	$r25\cdot1$	—·387 ± ·067	—·640 ± ·059
Maturation period (6)	$r16\cdot2$	—·367 ± ·068	—·032 ± ·100
	$r26\cdot1$	—·041 ± ·079	—·196 ± ·096

In lint length the influence of position is more strongly marked than that of the date of flowering, a result in agreement with Kearney's.[1] The general tendency for all characters, however, is to follow the same course of influence along the positions as that of the date of flowering. This is made clear from the regression curves, which run more or less similarly (Fig. 3).

[1] Kearney, T. Fibre Length and Height in Nodes of the Plant of Boll. *Jour. Agri. Res.*, XXVIII, pp. 563-565 (1924).

Regressions of characters on date of flowering and height in nodes of primary sympodial boll on plant.

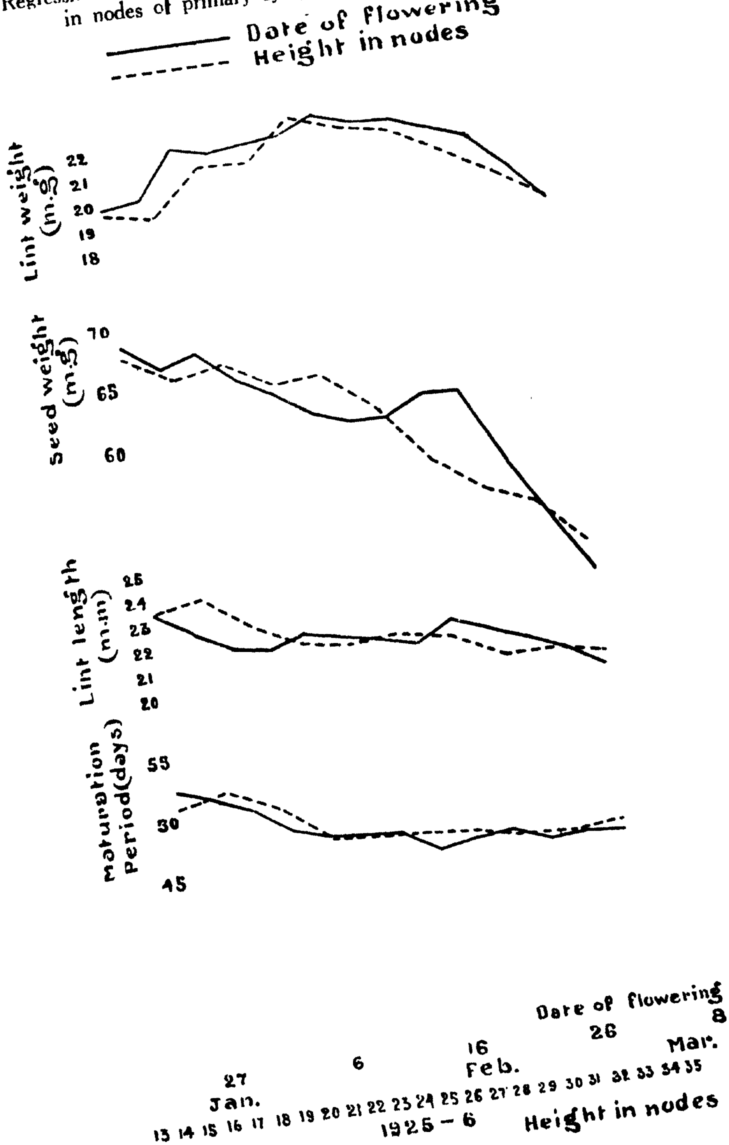

Fig. 3.

Variations due to temperature.

It does not fall within the scope of this paper to discuss the basic causes tending to the decline in characters of the later formed bolls. It is possible, as Pearsall[1] suggests, that earlier bolls have a prior claim on food supply, as also bolls of primary sympodia to those of secondary sympodia even of the same age. A close relationship has, however, been found to exist between the mean maximum temperatures and the maturation period of bolls developing at the time (Fig. 2). Judging from the figures of the year 1925-26, it will be seen that between the dates 22nd January and March 8th, the maximum temperature has risen from 86° to 95°F. The maturation period for these two periods are, respectively, 53·1 and 43·8 days, so that a rise of temperature of 9° has resulted in a reduction in the maturation period by about nine days. In the second year, the temperature is seen gradually to rise to 96°F. till the 20th of February when a fall occurs to 90°F. and is more or less maintained for some time. This rise and fall in temperature correspond to the fall and rise in the maturation period about February 9th, bolls from 11 days old and above being mostly influenced. This shortening of the maturation period consequent on a rise of temperature, is generally accompanied by a deterioration in character. Bolls undergo a hastened development; and a decline in quality is noted.

It is not known how far the influence of this factor affects the characters. The subject ought to be studied also in relation to the shortage of food supply (Pearsall)[1] and the depletion of assimilates (Mason)[2] mentioned by other workers. In Uppam cotton, the period of development of the boll is one of increased temperature, unrelieved by rain, and it is probable that these factors operate. In such a case also the later formed bolls will suffer most. It is possible that all these factors are together responsible for the full changes above noted.

Summary.

The variation of the cotton boll in the Uppam plant is seen to be one of decline in character as the season advances. The feature is perceptible from branch to branch of the main stem, and from node to node likewise of each branch, whether sympodial or monopodial. Within each branch the regressions along nodes follow much on the same lines as that indicated by the flowering period.

Besides the effect of the flowering period, the character of the boll is also fixed by the mode of branching. From flowers formed on the same date, the primary sympodia produce bolls of greater lint and seed weight than the secondary ones. Two factors are therefore concerned in the variation in Uppam cotton, namely,

[1] Pearsall. Studies in Growth Rate. *Annals of Botany*, XXXVII, p. 261.
[2] Mason, T. G. Growth and Abscission in Sea Island Cotton. *Annals of Botany*, XXXVI, p. 457.

a decline from primary to secondary sympodia within the same flowering period and a decline within each branch as this flowering period advances.

The characters for which such decline has been noted are seed weight, lint weight, lint length and maturation period. In the number of ovules and seeds per lock, however, no effect is seen with differences in the flowering period. Spinning tests also show that earlier picked cotton is better than the late pickings from the same field of a pure strain and is suitable for a higher standard of warp counts.

Acknowledgments.

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A SIMPLIFIED METHOD OF DETERMINING "STICKY POINT" OF SOILS.

BY

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A GOOD deal of attention is being directed at the present time towards standardizing methods of "single value" determination in soils. The object of "single vaules" is the characterization of a soil by measuring one property (or group of properties).

Well defined "single values" are indispensable in the genetic systems of soil classification which are receiving well deserved attention by modern soil scientists. Keen and Coutts[1] have discussed some of these "single values" with particular reference to English soils, and have elaborated the method of finding "sticky point" which is defined as the moisture content at which kneaded moist soil just ceases to adhere to external objects, and is determined as follows :—

About 10 grm. of soil are spread in a thin layer on a glass plate, and distilled water added from a fine jet until the soil is definitely wet and sticky. The mass is then worked into a paste with a knife spatula. A wooden handled palette (knife type) with a flexible steel blade about 13 cm. long and $2\frac{1}{2}$ cm. broad, is found very suitable for this purpose. The mass is then scraped from the plate and kneaded by hand until the soil has just reached the stage at which it no longer sticks to the hands or the knife. At this stage it is possible to cut cleanly through the plastic mass with the knife. A sample of the kneaded soil, after weighing, is dried in the steam oven to determine the moisture content.

The primary object of simplifying the method was to adapt it for use as a field method, but it turned out later that the simplified method was at least as accurate and reproducible as the one outlined above, and thus could replace the latter even in the laboratory with considerable saving of time.

DESCRIPTION OF THE PROPOSED METHOD.

Fifty grm. of air dry soil are spread on a stout glass plate, and water dropped over it gradually from a burette held in a clamp. After each small addition the soil and water are well mixed and worked into a paste with an iron spatula first and then with hand exactly as in the standard method. The sticky point can be

[1] Keen, B. A., and Coutts, J. R. H. *Jour. Agri. Sci.*, **18, 740 (1928).**

generally located within 2--3 drops corresponding to about 0·4 to 0·6 per cent. moisture content. The amount of water in c.c. × 2 gives the sticky point. This will be referred to as the burette method.

Forty-eight soils from various parts of India were used for comparison. The results of sticky point determinations are given in Table I. Three replicate determinations were made by the standard method on different days; this will give some idea of the degree of accuracy to be expected.

It will be clear from Table I that sticky point determinations can be made with reasonable accuracy for most soils. No special difficulty is encountered even in the case of highly dispersed alkali soils. However the "black cotton" soils containing as much as 50 per cent. clay or more give very indefinite values by either of the two methods, shown by the lack of agreement between replicate values in the standard method. and a large sticky range in the burette technique. In fact, perhaps, the non-applicability of the method serves to single these soils out, and it would be as well to record sticky point as "indefinite" rather than assign any particular value to it in such cases.

With the burette technique it was also possible to locate the sticky range; hence both the minimum and maximum values are recorded. The difference between the two probably represents the maximum error that might be expected in these determinations. As would be expected, in heavy clay soils the sticky range is very large.

A number of soils containing large amounts of air dry moisture show low values with the burette technique, which is due to the fact that in the standard method the air dry moisture is included in the sticky point. It will be seen that if the air dry moisture content is added to the value obtained by the burette technique, the difference no longer remains appreciable. However in all cases where the air dry moisture content is low the two methods give closely agreeing values. It is also a matter of consideration whether the value for sticky point should include the air dry moisture content. The writer is of opinion that, in working out any correlation between soil conditions and plant growth on the basis of sticky point determinations, it would be perhaps better to leave the hygroscopic moisture out of account. In any case, as it is customary in most soil laboratories, to record the air dry moisture contents separately, the difference is no serious hindrance to the adoption of the simplified method for routine work, as the air dry moisture could be added to the sticky point if required.

SUMMARY.

(1) A simplified technique for determining sticky point of soils has been outlined.

(2) Forty-eight soils, from different parts of India, have been compared and the simplified technique shown to give results identical with those obtained by the standard method as outlined by Keen and Coutts, if allowance is made for the air dry moisture content in the case of very hygroscopic soils.

TABLE I.

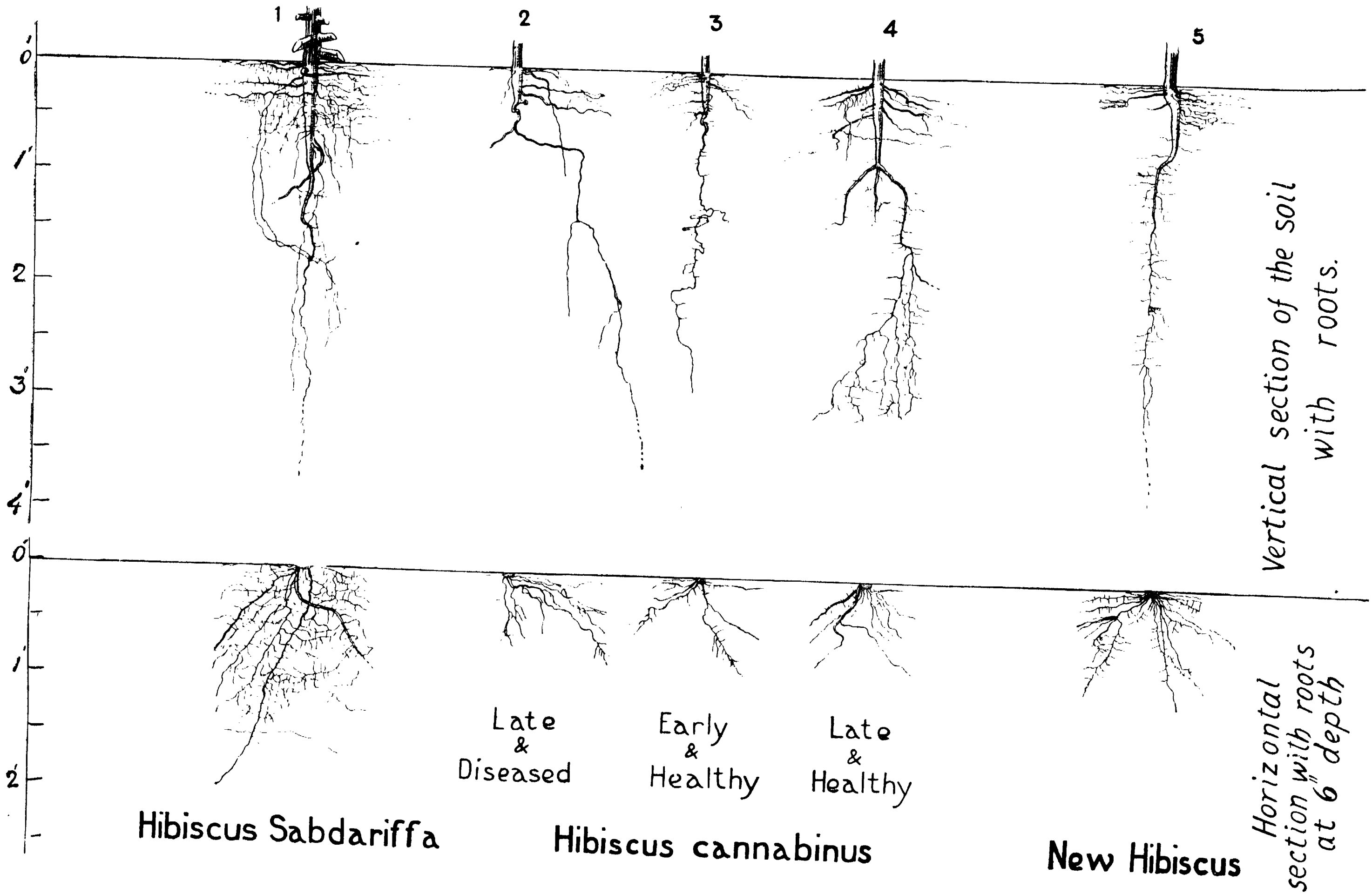
Comparison of sticky point values by the standard method and the burette method.

Serial No.		Description of soil	Laboratory No.	Sticky Point					Air dry moisture per cent.	† Clay 0·002 mm. per cent.
				Standard method			Burette method			
				(1)	(2)	(3)	Minimum	Maximum		
1	Punjab	Sir Ganga soil (good)	P C 4	22·6	22·0	21·4	20·0	21·8	1·36	15·2
2	Punjab	Sir Ganga soil (poor)	P C 5	23·1	23·05	21·2	21·4	22·8	1·14	12·3
3	Punjab	Typical Bara soil from Montgomery District	P C 7	21·9	20·1	19·2	19·6	20·0	1·86	21·8
4	Punjab	Lyallpur Agricultural College Farm	P C 16	..	19·9	20·0	20·0	21·6	0·58	8·6
5	Punjab	Gurdaspur Agricultural Farm Field C/6, plot 3, control	P C 34	22·2	22·4	21·8	22·0	26·8	0·93	11·3
6	Punjab	Barani soil, Gurgaon	P C 35	21·4	20·7	21·0	19·4	22·4	1·79	18·3
7	Punjab	Bhalla soil near Hansi	P C 36	20·9	20·3	20·6	22·0	23·8	0·97	11·7
8	Punjab	Bara soil gypsum treated, crops not well.	P C 47	21·2	18·8	20·0	19·4	20·2	0·85	17·1
9	Punjab	Bara soil gypsum treated, crops well.	P C 48	24·6	22·0	24·0	23·6	24·8	1·01	19·8
10	United Provinces	Kalyanpur soil	P C 17	23·0	24·9	24·7	25·8	26·4	1·05	14·1
11	United Provinces	Soil from Meerut	P C 24	25·4	24·6	24·3	?	26·0	0·89	9·7
12	United Provinces	Bhur soil, Mainpuri	P C 25*	26·6	23·9	26·2	26·6	28·3	0·24	4·0
13	Central Provinces	Nagpur College Farm, black cotton soil.	P C 13*	49·1	40·0	39·4	31·6	34·6	9·60	58·9
14	Central Provinces	Morand soil	P C 28*	36·6	28·6	30·4	25·0	26·2	6·53	44·6
15	Central Provinces	Khapar soil	P C 29*	47·4	40·4	39·2	28·8	34·8	9·61	63·0
16	Central Provinces	Marujar soil	P C 30*	47·5	38·9	39·9	31·4	38·0	10·30	54·1
17	Central Provinces	Akola soil	P C 2*	45·3	41·3	47·6	33·2	37·6	11·24	59·3
18		Dharwar soil	P C 3*	53·6	46·9	47·0	35·0	38·4	10·89	62·2
19		Broach cotton soil	P C 38*	45·5	38·1	40·8	31·0	36·0	8·22	52·9
20		Soil from Tobacco Station, Nadiad.	P C 39	22·5	22·6	22·7	22·0	23·6	1·55	8·4

21	Bombay	Umareth soil	P C 40	22·9	22·2	24·6	23·8	27·2	1·33	13·1
22		Poona soil	P C 41*	45·7	41·9	43·5	31·2	38·4	9·61	53·4
23		Khandesh soil	P C 42*	51·1	49·0	54·7	34·4	38·4	10·09	53·4
24		Black Karjan soil (Baroda)	P C 46*	50·7	40·1	..	33·8	35·6	9·85	56·4
25		Composite sample of Pusa soils.	P C 1	27·0	25·0	28·3	25·1	26·4	0·57	11.3
26	Bihar	Chur-land soil	P C 43	29·5	28·5	28·7	26·0	30·0	2·42	21·6
27		Fine high land soil	P C 44	28·7	26·4	25·2	28·6	30·8	0·82	8·4
28		Ordinary high land soil	P C 45	24·7	24·4	25·5	25·5	28·0	0·84	11·1
29	Bengal	Dacca acid soil	P C 6	31·4	29·6	25·8	27·9	29	2·31	28·4
30		Tobacco soil, Rangpur	P C 37	32·7	30·7	33·0	38·0	36·4	0·96	4·1
31		Coimbatore soil	P C 8	22·4	23·1	21·0	19·4	21·4	3·13	25·2
32		Malabar soil	P C 9	26·8	25·6	23·8	25·0	26·2	1·51	21·6
33	Madras	Soil from cotton breeding station (Coimbatore).	P C 10	31·8	29·3	27·8	23·2	24·1	5·00	35·6
34		Student's plot, Coimbatore.	P C 11*	29·2	21·0	27·2	22·7	24·3	4·67	32·8
35		A composite sample from few estate soils.	P C 14	41·3	36·0	49·0	38·4	..	3·31	21·5
36	Assam	Tocklai-soil	P C 12	22·8	21·7	22·1	22·8	23·4	1·60	7·2
37		Shillong soil	P C 15	35·0	32·5	33·2	28·6	30·0	2·21	22·4
38		Acid soil from Burma	P C 18	35·2	31·0	31·5	32·0	33·8	1·39	22·6
39		Sano-Putchi Mandalay Farm.	P C 19*	35·3	30·0	29·7	25·4	27·6	5·07	42·8
40	Burma	Rubber soil	P C 20	20·2	19·5	19·9	20·0	21·0	0·59	8·1
41		Kaing or non soil	P C 21	31·9	30·0	30·4	28·4	31·8	1·68	13·5
42		Pyin ana sugarcane soil	P C 22	23·9	22·5	22·6	21·8	24·0	1·61	15·1
43		Mya-tha soil	P C 23	21·6	20·9	21·1	21·6	24·2	1·27	11·3
44		Loamy soil of paddy lands	P C 31	27·3	24·2	27·4	22·6	26·0	2·90	22·8
45	Travancore	Thuravoor soil	P C 32*	55·0	49·3	51·8	41·8	46·2	7·38	64·6
46		Alkali soil	P C 33	16·4	16·4	16·7	16·0	17·4	0·61	2·6
47	Mysore	Red ragi soil, Hebbal	P C 26	20·5	18·0	20·6	20·2	21·1	0·94	22·5
48		Black cotton soil, Babbur	P C 27*	49·0	32·1	38·2	30·8	32·2	10·25	53·2

† Clay determined by the (Na Cl-NaOH) method developed by the writer (*Mem. Dept. Agri. India. Chemical Series*, Vol. X, No. 8).
* Values indefinite.

PLATE V.



1
2
3
4
5
0'
1'
2
3'
4'
0'
1'
2'
Vertical section of the soil with roots.
Late & Diseased
Early & Healthy
Late & Healthy
Horizontal section with roots at 6" depth
Hibiscus Sabdariffa
Hibiscus cannabinus
New Hibiscus

A NEW TYPE OF ROSELLE HEMP.

BY

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First Assistant to Imperial Economic Botanist.

Hibiscus is a genus belonging to the Malvaceæ Order, which embraces about 150 species. Some of the species are of considerable economic importance, and of these, two, (1) H. *Sabdariffa* and (2) *H. cannabinus*, are commonly grown in India.

(1) *H. Sabdariffa* Linn. (Patwa, Roselle).

This is chiefly grown, as a garden crop on a small scale, for its fleshy calyx which is a valuable antiscorbutic, largely eaten in the form of jellies, *chatnies* and other preserves. Its branches yield a good fibre, the roselle hemp of commerce. In this respect it resembles *H. cannabinus* Linn., but having a bushy and branched habit is not very suitable for fibre making.

(2) *H. cannabinus* Linn. (Deccan hemp, ambari hemp, *ambadi, pulu, darekudum, sheria, pundu gogu, sujjado, sankukra, mesta pat, patsan*, Bamlipatm jute).

This is a straight growing plant of unbranched habit and therefore is much more suitable for fibre making than *Sabdariffa*. For this purpose it is largely grown in Bombay, Madras and Central Provinces and to a smaller extent throughout Northern India. It grows well under drier conditions than are necessary for jute (*Corchorus*) and does not thrive well on rice lands where its roots are waterlogged.

The Howards isolated[1] and described 4 types of *Sabdariffa* and 8 types of *cannabinus* which have been maintained up till now by the Botanical Section. In 1927 some seed of *Calopogonium mucunoides* Desv. was obtained from Java and in the crop grown from this seed a stray plant of an unknown type of *Hibiscus* was noticed. This plant grew to a considerable height having a straight almost unbranched stem and appeared to possess the habit of *cannabinus* with some morphological characters of *Sabdariffa*. The habit of this new type in contrast with that of *H. Sabdariffa* and *H. cannabinus* is well shown at Plate VII, fig. 1. Specimens were referred to the Royal Botanical Gardens, Calcutta, to Kew and to Buitenzorg and by all these authorities the plant was placed in *H. Sabdariffa* Linn. The characters of this new type together with those of *H. Sabdariffa* and H. *cannabinus* are shown below. The description of the last two species has been taken from Hooker's "Flora of British India".

[1] *Memoirs of the Department of Agriculture in India, Botanical Series*, Vol. IV, No. 2, 1911.

	Hibiscus cannabinus	*Hibiscus Sabdariffa*	*New Hibiscus*
Plant . .	Annual or perennial and prickly.	Annual . . .	Annual, erect and prickly.
Stem . . .	Glabrous and prickly .	Purplish, glabrous and unarmed.	Hairy, bristly with small minute tubercules. Green in early stage and purplish near maturity.
Leaves . .	Lower leaves entire and cordate; upper leaves lobed and deeply palmated; lobes narrow and serrate. Mid nerve glandular beneath. Petiole prickly, lower and much longer than the blade.	Entire or lobed, polymorphous. Mid nerve glandular beneath. Petiole two inches long (shorter than the blade).	Lower leaves entire; upper leaves palmately lobed; lobes narrow and serrate. Mid nerve glandular beneath. Petiole lower surface prickly, shorter than the blade and two to three inches in length.
Flower . .	Corolla large, spreading, yellow with a crimson centre. Sepals glandular, bristly, lanceolate, connate below the middle with a gland at the back of each. Bracteoles 7 to 10, linear, shorter than the calyx. Stipules linear and pointed Peduncle very short and axillary.	Corolla yellow (common types with crimson eye). Sepals bristly, calyx acrescent, deltoid, accuminate, connate below the middle into a purplish fleshy cup. Bracteoles 8 to 12, linear, adnate to the base of the calyx, acrescent. Stipules linear and pointed Peduncle very short and thickened at summit, solitary, axillary and shorter than petiole.	Corolla yellow with crimson eye. Sepals hairy, somewhat fleshy when green but dry when ripe with a gland at the back of each. Vary to a certain extent even in the same plant but never grow much above the capsule as they do in common types of *Sabdariffa* (Plate VI). Bracteoles 7 to 10 without appendages, linear, adnate to the calyx tube and appressed. Stipules linear, pointed and hairy. Peduncle axillary, shorter than petiole and expanded at the summit.
Fruit . .	Capsules globose, pointed and bristly. Seeds nearly glabrous .	Capsules ovoid, pointed, villous and shorter than the calyx. Seeds reniform and subglabrous.	Capsules ovoid or pointed, equal to or larger than calyx, hairy with long hairs. Seeds glabrous and reniform.

From the above statement it is evident that the new *Hibiscus* differs from *H. Sabdariffa* in the fruit having a non-edible calyx and in habit in having an erect and non-branching prickly stem like that of *H. cannabinus*. It differs from *cannabinus* in the flower and root-system and in its immunity to disease. It differs

from the common types of both in having a hairy and bristly stem (Plate VI). The new type of *H. Sabdariffa* appears to be identical with one described by Wester[1] under the name *H. Sabdariffa* var. *altissima*. Wester describes two types of *altissima*, one kind belonging to the red type of roselle and the other being intermediate between red and green. Both types are tall and sparsely branched and the type which has been grown at Pusa appears to belong to the intermediate form. The *altissima* types of *H. Sabdariffa* are native to the Gold Coast, West Africa; it is not known whether the plant has any economic significance in this region. The seed of the new type has not yet been obtained in sufficient quantities to grow it on a large scale but on a small plot it produced 39 maunds of fibre per acre and the fibre has been reported to be very good (Plate VII, fig. 3).

The four original types of *H. Sabdariffa* Linn. isolated by the Howards are more or less useless for fibre purpose as their habit is branching and bushy. The new type may prove of considerable utility as it possesses a longer and less branched stem than *H. cannabinus* and seems to be immune to the curious disease which has affected *H. cannabinus* Linn. for some years past at Pusa (Plate VII, fig. 2), and which up to the present has never appeared on any of the types of *H. Sabdariffa*. The Howards in 1920[2] called this disease wilt and observed that the surface-rooted roselle crop and the early types of *patwa* (*cannabinus*) do well at Pusa even when the soil is water-logged, while the deep-rooted types of *patwa* (*cannabinus*) in such seasons suffered severely from wilt.

Whatever may be the cause of this disease, there is no doubt that excess of moisture and certain physiological conditions in the soil have an injurious effect on the root-system of the plant, and that the appearance of the disease is correlated with the death of the fine roots. In 1929 all the types were grown in the same plot and their roots were examined and are shown in Plate V, the contrast between the roots of diseased plants and those of healthy plants is very striking; both vertical and horizontal sections of the soil with roots are shown. Fig. 1 shows the root-system of *H. Sabdariffa* var. *ruber* which has a very luxuriant surface root-system. Figs. 3 and 4 show the root-system of healthy plants in *Hibiscus cannabinus*, early and late varieties respectively. Fig. 2 shows the root-system of a late and diseased plant of *H. cannabinus*; it will be noticed that all the fine roots are dead. Fig. 5 shows the root-system of the new *Hibiscus*. It will be noticed that in this type the finer roots are in a surface root-system which is well developed. This new type was not attacked by the disease, while T. 8 *H. cannabinus* which was grown side by side with this new type had all its plants badly attacked by the disease (Plate VII, fig. 2).

The new type of *Hibiscus* grows well in the climate of Bihar and appears to reach its full growth on a much smaller rainfall than is required for jute. Sowing in Bihar should be in June-July and the fibre is then ready for retting in September-October.

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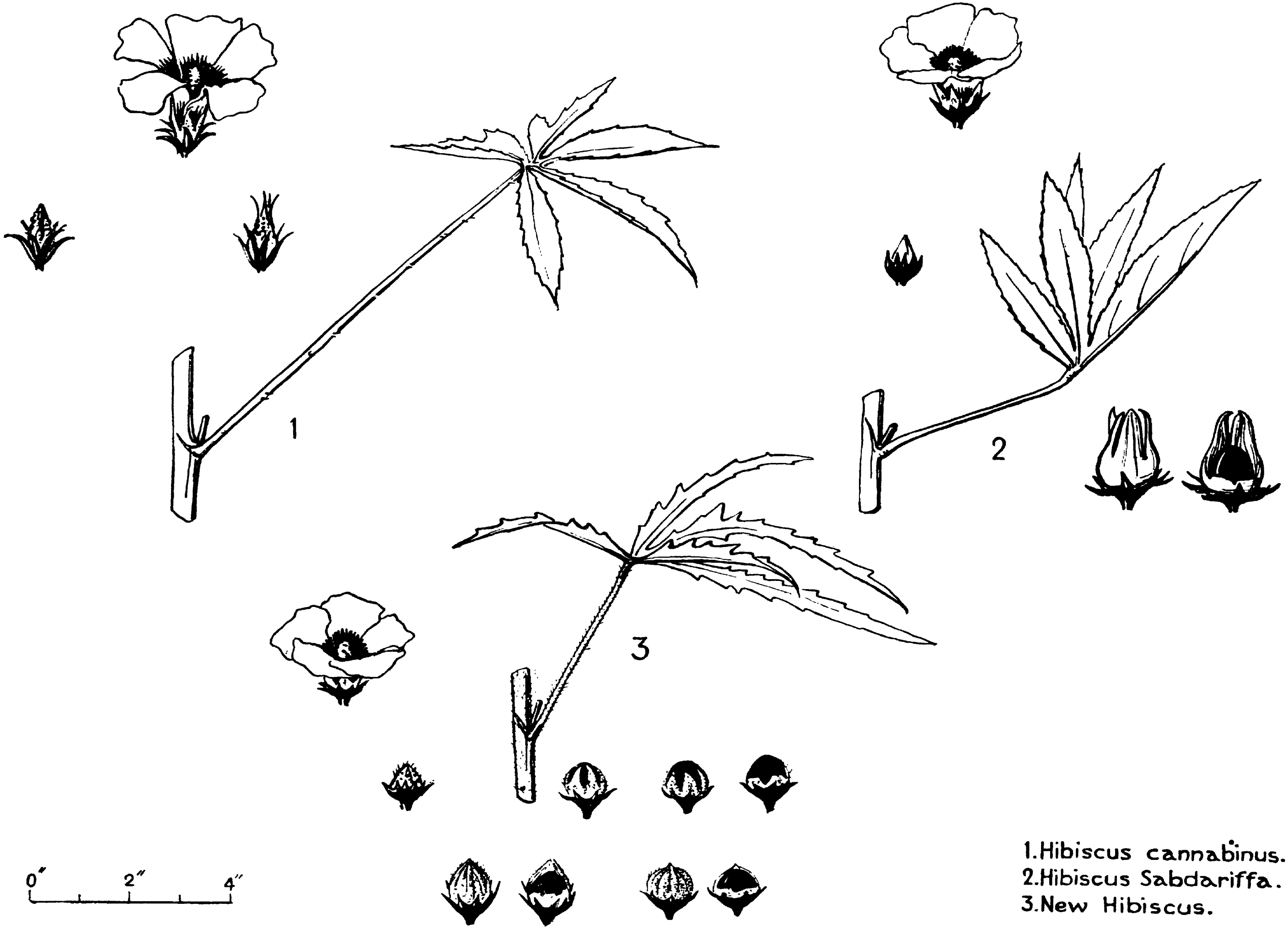
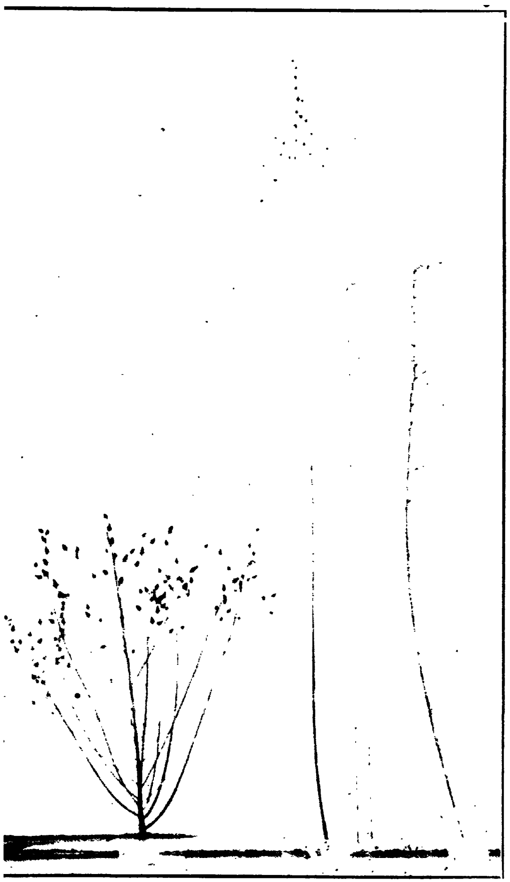
[1] New Varieties of Roselle, by P. J. Wester. *Philippine Agric. Review*, Vol. VII, page 268, 1914.
[2] *Memoirs of the Department of Agriculture in India, Botanical Series*, Vol. XI, No. 1, 1920.

PLATE VI.



1.Hibiscus cannabinus.
2.Hibiscus Sabdariffa.
3.New Hibiscus.



1. (From Left) H. S. albus, New Hibiscus, H. cannabinus T. 3.

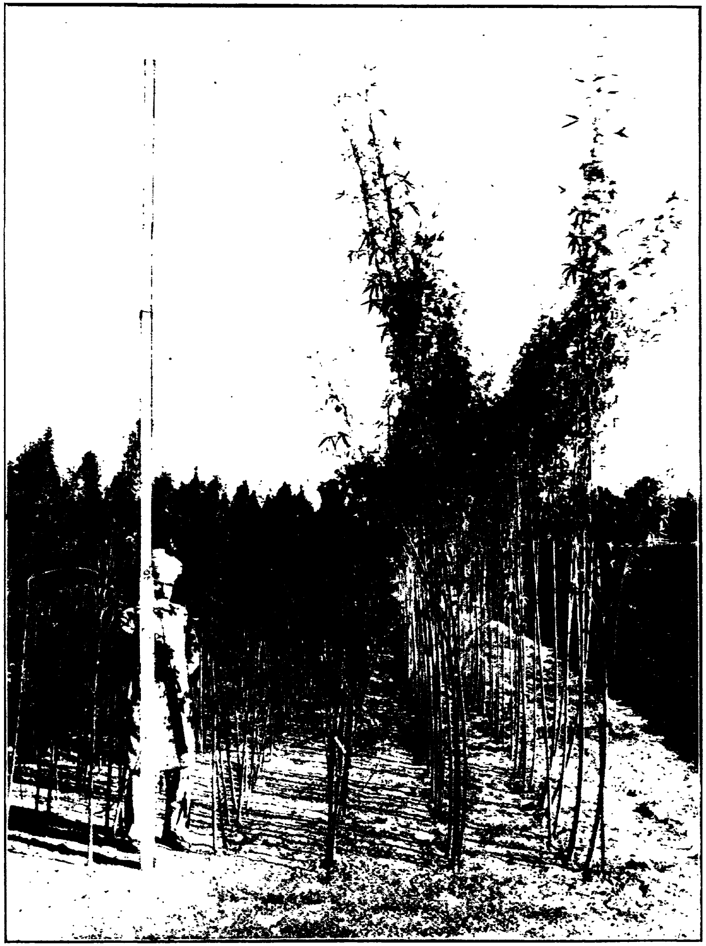


Fig. 2. Left, H. cannabinus T. 8—all plants diseased.
Right, New Hibiscus—all plants healthy.

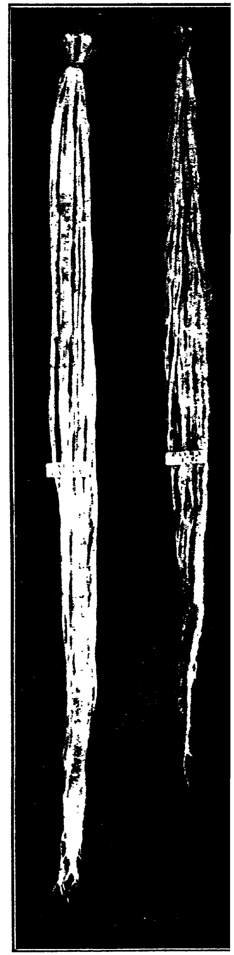


Fig. 3. Left, New Hibiscu
Right, H. cannabinus T. 3.

THE USE OF SMALL ADDITIONS OF ACID FOR INCREASING THE GERMICIDAL ACTION OF E. C. ON BACTERIAL SPORES.*

BY

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In a recent paper by Cruess and Richert,[1] the retarding effect of sodium benzoate on the rate of multiplication of *Saccharomyces Ellipsoideus* and other food spoilage organisms was found to be stronger at pH values of 2·5 to 4·5 than 5·0 to 9. They found that the spoilage of apple and grape juice, which was acid, by yeast and mould was prevented by 0·1 per cent. or less of sodium benzoate, whereas 0·2 per cent. failed to prevent the growth of bacteria and mould in avocado pulp and in non-acid vegetables stored in weak brine.

In our recent experiments on the germicidal efficiency of E. C. on bacterial spores, it was observed that some of the spores were much more resistant than others to the action of the disinfectant; *e.g.*, the spores of *B. Mesentericus* were not killed by E. C. in a concentration of 1 in 100 even after 60 minutes' contact, whereas the spores of *B. Mycoides* were killed in a dilution of 1 in 1,000 after 15 minutes' contact. As all these experiments were conducted by diluting E. C. with distilled water of pH about 7·0, it was thought advisable to try the effect of E. C. of different concentrations on some of these refractory spores in a medium the pH of which had been decreased by the addition of acid, the object aimed at being to find out the minimum concentration of E. C. together with the least amount of acid to effect complete destruction of these resistant spores and the minimum time of contact necessary.

EXPERIMENTAL.

The method of testing the germicidal efficiency was the one elaborated by us in our previous studies [2] and is in brief as follows :—

Growth from an old culture of the resistant organisms was emulsified in sterile water and this was boiled for 5 minutes to kill off all vegetative growth. A

* Paper read at the Indian Science Congress, Allahabad, 1930.

[1] Cruess, W. V.; and Richert, P. H. Effect of hydrogen ion concentration on the toxicity of sodium benzoate to micro-organisms. *Journal of Bacteriology*, Vol. XVII, page 363, 1929.

[2] Ram Ayyar, C. S. A comparative study of the germicidal efficiency of E. C. and formalin on bacterial spores. *Agri. Jour. India*, Vol. XXV, Pt. I, 1930.

definite quantity of this emulsion was diluted with 100 c.c. sterile water to which varied amounts of E. C. and acid were subsequently added. After keeping them in contact for different lengths of time, with frequent shaking, 2 loopfuls were taken and inoculated into agar and plates poured out of the same. A control plate was also poured, to note down the number of spores originally present in the above inoculum. These were then incubated at 30°C. and the number of colonies which developed in the plates after 3 days' incubation counted.

The following tables give the different treatments and the number of colonies which developed on the plates. :—

Experiment I.

Test organism—Spores of *B. Mesentericus*, 0·5 c.c. emulsion added to sterile water 100 c.c.
E. C.—0·2 c.c.
N/1 HCl—1 c.c.
Time of contact—5, 15 and 30 minutes.

	Number of colonies after		
	5 minutes	15 minutes	30 minutes
1 : 500 E. C.	600	550	400
N/1 HCl 1 per cent.	..	..	Innumerable.
1 : 500 E. C. + N/1 HCl 1 per cent.	400	nil	nil
Control			Innumerable.

This shows that E. C. by itself in a dilution of 1 : 500 does not effect complete destruction of spores even after 30 minutes' contact, whereas the addition of 1 per cent. normal acid to the liquid effects complete destruction after 15 minutes' contact. The addition of acid alone does not materially reduce the number of spores germinating.

Experiment II.

The addition of acids other than mineral acids was next tried. Citric acid was selected as it is easily available and cheap. A normal solution was prepared by

dissolving 7·0 grams of the pure acid in 100 c.c. water and this was used in the following experiments :—

Test organism—Spores of *B. Mesentericus*, 0·5 c.c. emulsion added to 100 c.c. sterile water.

E. C.—0·1 c.c.

N/1 citric acid—1·0 and 0·5 c.c.

Time of contact—30 minutes.

	Number of colonies after 30 minutes
1 : 1,000 E. C.	1,800
1 : 1,000 E. C. + N/1 citric acid 1 per cent.	nil
1 : 1,000 E. C. + N/1 citric acid 0·5 per cent.	2
N/1 citric acid 1 per cent.	6,700
Control	About 8,000

From this it is evident that citric acid is equally efficient as hydrochloric acid, when used in combination with E. C.

Experiment III.

The next point to be ascertained was the minimum concentration of E. C. to be used in conjunction with acid to effect complete destruction. The addition of 0·5 per cent. normal citric acid was tentatively taken as the quantity of acid to be used.

Test organism—Spores of *B. Mesentericus*, 0·5 c.c. emulsion added to 100 c.c. sterile water.

E. C.—1 : 2,000, 1 : 1,000, 1 : 500 and 1 : 200.

N/1 citric acid—0·5 c.c.

Time of contact—30 minutes.

	Number of colonies after 30 minutes
E. C. 1 : 2,000 + 0·5 per cent. N/1 citric acid	320
E. C. 1 : 1,000 + ditto	26
E. C. 1 : 500 + ditto	nil
E. C. 1 : 200 + ditto	nil
Control	About 6,400

A concentration of 1 : 500 may be considered the minimum required for destruction of these spores in conjunction with the acid.

Experiment IV.

In this experiment, the spores of *B. Albolactus*, isolated from milk which was found difficult to sterilize, were used. Varying periods of contact and different concentrations of E. C. were tried here, keeping the quantity of acid added constant, *viz.*, 0·5 per cent. N/1 citric acid. The results are given in the table below :—

Test organism—Spores of *B. Albolactus*, 0·5 c.c. emulsion added to 100 c.c. sterile water.

E. C.—1 : 2,000, 1 : 1,000 and 1 : 500.

N/1 citric acid—0·5 c.c.

Time of contact—5, 15 and 30 minutes.

	Number of colonies after		
	5 minutes	15 minutes	30 minutes
E. C. 1 : 2,000 + 0·5 per cent. normal citric acid .	2,000	1,720	1,840
E. C. 1 : 1,000 + ditto .	1,800	840	650
E. C. 1 : 500 + ditto .	1,650	30	2
Control .			About 7,920

Two facts emerge from this table :—(1) A dilution of 1 : 500 E. C. + 0·5 per cent. acid is the minimum required for the complete sterilization of these spores, and (2) thirty minutes' contact is barely sufficient to effect the same.

Experiment V.

The above experiment as regards the time of contact was repeated with *B. Albolactus* spores. Instead of sterile water ordinary tap water was used. 5 c.c. of the emulsion was added to 1,000 c.c. tap water which was divided into two equal parts and 2·5 c.c. and 0·5 c.c. N/1 citric acid added to each. 1 c.c. of E. C. was then added to each and plates were made using 0·1 c.c. for inoculation, the time of contact being 5 minutes, 15 minutes and 30 minutes.

For the control plate also, 0·1 c.c. of the inoculum was used. The number of colonies which developed is shown in the following table :—

Test organism—Spores of *B. Albolactus*, 2·5 c.c. emulsion added to 500 c.c. tap water.

E. C.—1 : 500.

N/1 citric acid—0·5 c.c. and 2·5 c.c.

Time of contact—5, 15 and 30 minutes.

	Number of colonies after		
	5 minutes	15 minutes	30 minutes
1 : 500 E. C.	6,800	2,300	1,800
1 : 500 E. C. + 0·5 per cent. N/1 citric acid . .	1,200	60	2
1 : 500 E. C. + 0·1 per cent. ditto . .	1,100	50	4
Control .			About 60,000

From the above table it is again clear that at least 30 minutes' contact is necessary for the complete destruction of the spores. Further, it appears that a much less amount of acid might work as effectively as larger additions.

Experiment VI.

To elucidate this point, *viz.*, to find out the minimum amount of acid to be added to effect complete sterilization, the following experiment was started :—

Test organism—Spores of *B. Mesentericus*, 0·5 c.c. emulsion added to 100 c.c. sterile water.

E. C.—1 : 500.

N/1 citric acid—0·5 c.c., 0·25 c.c., 0·1 c.c. and 0·05 c.c.

Time of contact—15 minutes and 30 minutes.

	Number of colonies after	
	15 minutes	30 minutes
1 : 500 E. C. + 0·5 per cent. acid	9	1
1 : 500 E. C. + 0·25 ditto	9	1
1 : 500 E. C. + 0·1 ditto	55	3
1 : 500 E. C. + 0·05 ditto	400	3
E. C. 1 : 500 alone .	1,600	820
Control .		2,925

Here, again, the minimum time of contact for efficient sterilization is 30 minutes, and it appears that as small an addition as 0·05 per cent. N/1 citric acid is quite effective in practically complete destruction of spores.

Experiment VII.

To make sure that the amount of acid added, *viz.*, 0·05 per cent., is really effective, spores of 3 typical refractory organisms were taken, *viz.*, *B. Subtilis*, *B. Albolactus* and *B. Mesentericus*. Emulsions were added to 1,000 c.c. tap water. Each was divided into two equal parts and to one was added 1 c.c. E. C., to the other 1 c.c. E. C. and 0·25 c.c. normal citric acid. After thorough shaking and keeping for 30 minutes, plates were made from them using 0·1 c.c. for inoculation. A control plate was also made from each at the beginning to see the number of spores introduced. In the case of E. C. alone, plates were made after 60 minutes' contact also. The results appear from the table below :—

	Number of colonies of		
	B. Subtilis	*B. Mesentericus*	*B. Albolactus*
1 : 500 E. C.—30 minutes' contact . . .	1,330	1,450	60
1 : 500 E. C. + 0·05 per cent. N/1 citric acid—30 minutes' contact.	nil	nil	nil
1 : 500 E. C.— 60 minutes' contact . . .	33	268	nil
Control—Original .	19,200	47,700	4,500

Concordant results have been obtained in the case of the three organisms tested, *viz.*, that E. C. in a dilution of 1 : 500 together with the addition of 0·05 per cent. normal citric acid completely destroys the spores after 30 minutes' contact. E. C. alone in the above dilution does not destroy all the spores after 60 minutes' contact, although the number of spores which are alive is reduced to a considerable extent.

The hydrogen ion concentration of 100 c.c. distilled water to which 0·05 c.c. of N/1 citric acid solution was added, was determined colorimetrically and potentiometrically and it was found to have pH value of 3·9 in both cases.

Conclusion.

From a study of the foregoing tables, the increased efficiency of acidulated E. C. in killing bacterial spores is clearly evident. The addition of 0·05 per cent. normal citric acid solution in conjunction with 0·2 per cent. E. C. (*i.e.*, 3·5 grm. of citric

acid and 200 c.c. E. C. to 100 litres of the liquid) destroys practically completely the spores of some refractory bacteria after 30 minutes' contact. With E. C. alone, these were not destroyed in the above dilution of 1 : 500 even after 60 minutes' contact.

The practical value of these tests lies in the fact that sericultural houses could be disinfected with greater certainty by adding the above amount of acid to the diluting water before the addition of E. C. and then spraying the walls, roof, etc.

A SHORT SURVEY OF GRASSLAND PROBLEMS IN THE CENTRAL PROVINCES.

BY

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The importance of grasslands in Indian agriculture requires no emphasizing and it is indeed surprising that they should until recently have received so little attention. With the spread of knowledge of scientific agriculture, however, grasslands in future are bound to receive their due share of importance. The Royal Commission on Agriculture in India have clearly pointed out that no substantial improvement in the way of breeding is possible until cattle can be better fed. There is no question that improved grass areas managed on scientific lines would go a long way towards solving this problem.

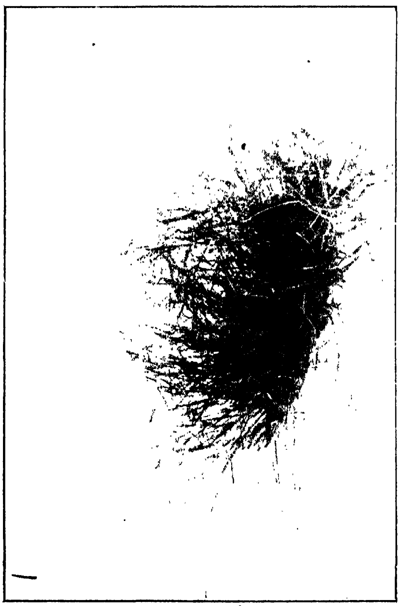
The purpose of this article is to give an account of some of the results which have been obtained during the past four years in work on the improvement of grasslands in the Central Provinces and to offer suggestions for increasing the produce of such lands, based largely on experiments made in different parts of the province.

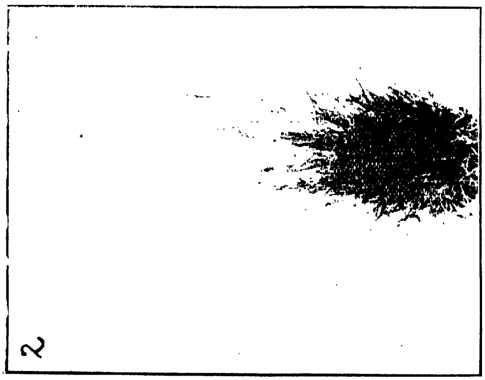
In December 1925, the subject of the suppression of spear grass and the improvement of grass areas in these provinces was considered at some length by the Provincial Board of Agriculture. The Botanical Section was entrusted with this work early in 1926.

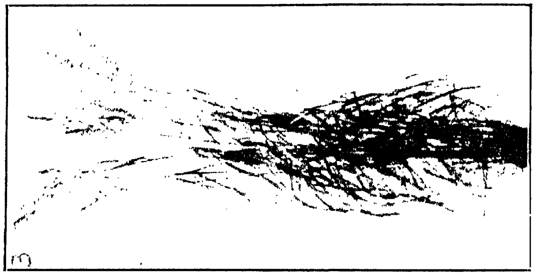
Investigations.

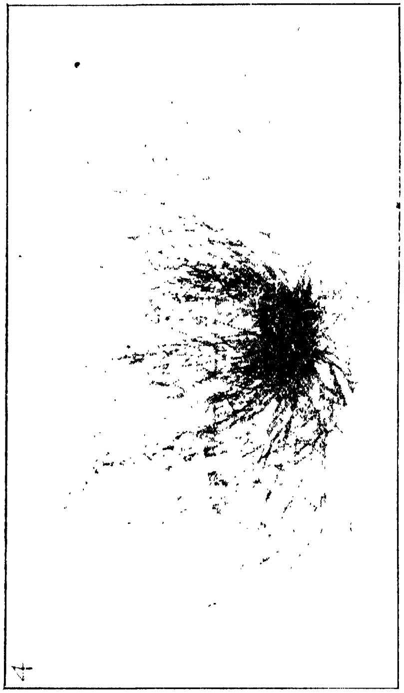
It was realized at the outset that no material progress could be achieved unless first a general survey of the typical grass areas was made. Investigations were accordingly started and it soon became obvious that the suppression of spear grass was but a small item in the work of improvement, the general condition of the herbage of the areas examined being far from satisfactory. Several causes may be attributed to this state of affairs. In the first place, while arable land has been receiving more and more attention, grasslands have been left to shift for themselves, with the result that weeds and coarser grasses have considerably increased in them. Secondly, unrestricted and close grazing always leads to a very rapid depletion of the soil unless it be continuously supplied with easily available mineral fertilizers. The herbage on such worn-out soils is naturally of a very poor quality.

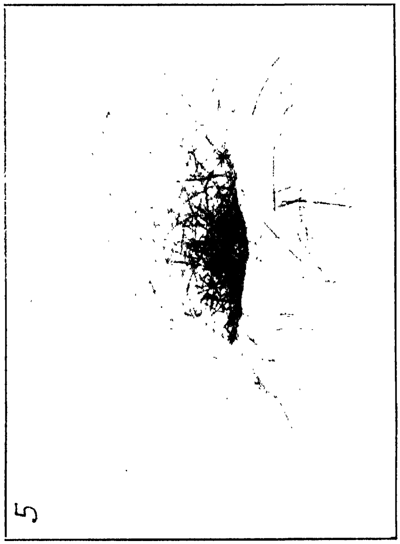
PLATE VIII.











1. *Ischaemum sulcatum.*
2. *Ischaemum laxum.*
3. *Andropogon purpureo-sericeus.*
4. *Iseilema laxum.*
5. *Andropogon annulatus.*

Moreover, it has been observed that in areas where animals are allowed to roam about at their own free will, the inferior and coarser grasses are invariably left uneaten by them and these thus have a greater chance of seeding and spreading than the finer grasses. Untouched patches of spear grass, for instance, are, by no means, an uncommon sight in the grazing areas of this province.

Experimental work was, therefore, started with a view to finding out suitable means for replacing the coarser varieties by more suitable and better ones and generally to improve the quality and yield of the herbage of our grasslands. The sites selected were Borgaon, Raipur and Nagpur.

The first step was to make a detailed and close study of all the grasses and leguminous plants occurring in the grasslands of these provinces from the points of view of habit of growth, palatability, nutritive value and yield. It was discovered that with the exception of the following indigenous varieties, the rest were not of any very great importance :—

1. *Ischaemum sulcatum*, vern. *Paona* (Fig. 1).

This is an excellent grass, much relished by cattle. It has been found to occur in considerable masses on all our good soils.

2. *Ischaemum laxum*, vern. *Sheda* (Fig. 2).

This grass is very similar to *Ischaemum sulcatum* but as a rule grows much taller and possesses longer leaves. The most constant but purely botanical distinguishing character is that the outer glume is six-nerved, while in *Ischaemum sulcatum* it is only two-nerved. In Berar, this grass is reckoned to be one of the best fodder grasses and a good yielder.

3. *Andropogon purpureo-sericeus*, vern. *Sani baba jara* (Fig. 3).

Experiments have shown it to be a good fodder. Gives a fair yield, is a quick grower and acts as a nurse crop in the early stages of newly laid down grassland.

4. *Iseilema laxum*, vern. *Mushyal* (Fig. 4).

This must be considered as one of the best fodder grasses of the province. It is much liked by the cattle, is a good yielder and owing to its heavy foliage is excellent for hay-making.

5. *Andropogon annulatus*, vern. *Lahan marvel* (Fig. 5).

This grass yields good fodder and sweet-scented hay. Stands cutting well.

6. *Andropogon caricosus*, vern. *Mothi marvel* (Fig. 6).

This grass resembles *Andropogon annulatus*. The main points of difference are that the base is distinctly more creeping, the nodes are not hairy and the racemes

are longer, solitary or only two together with spikelets more or less arranged in two rows. It has been found to be a good fodder, equal to *Andropogon annulatus* in its feeding value.

7. *Andropogon pumilus*, vern. *Diwaratan* (Fig. 7).

This grass gives a good bottom covering but does not appear to be liked by the cattle in its green state to the same extent as other good grasses. Good hay can, however, be made from it.

8. *Andropogon pertusus*, vern. *Kel* (Fig. 8).

This is a beautiful fodder grass, sweet, succulent and nutritious. Makes hay of good quality, but its yield is, comparatively speaking, low.

9. *Andropogon monticola*, vern. *Gada sela* (Fig. 9).

Quite a good fodder grass but the proportion of leaf to stem is low. It is very common on stony lands. When grown in mixture, its yield in the first few years is rather low but gradually increases owing to its prolific spreading power.

10. *Apluda varia*, vern. *Ponai* (Fig. 10).

A good early grass. Yields a fairly good fodder. But as the proportion of leaf to stem is very small at normal hay-making time, it does not give good quality hay.

11. *Alysicarpus rugosus*, vern. *Shevara* (Fig. 11).

This leguminous plant occurs in most good grasslands of the province and its growth should be encouraged as much as possible.

12. *Indigofera linifolia*, vern. *Bhui juar* (Fig. 12).

Another valuable leguminous weed of grasslands.

The botanical description of these important grasses and legumes is given at the end of this paper.

While this work was in progress, seeds of exotic species, European, Australian, African and American, were obtained and experimented with in order to find out if any of them might prove useful for sowing out our grass areas. The results of these experiments showed that while some of them are useful fodders and can be successfully grown during certain periods of the year or in places where irrigation facilities are readily available, their use in our permanent grasslands cannot be recommended. The herbage in permanent grass must consist almost entirely of indigenous species that are proper to the varying conditions of soil and climate. Selection in favour of the more desirable plants can be made by scientific management, *i.e.*, grazing, manuring, etc. Attention was therefore concentrated on the

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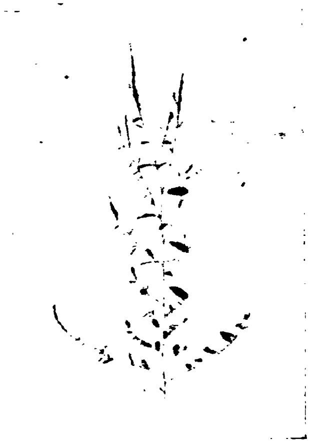
6. *Andropogon caricosus.*
7. *Andropogon pumilus.*
8. *Andropogon pertusus.*
9. *Andropogon monticola.*
10. *Apluda varia.*

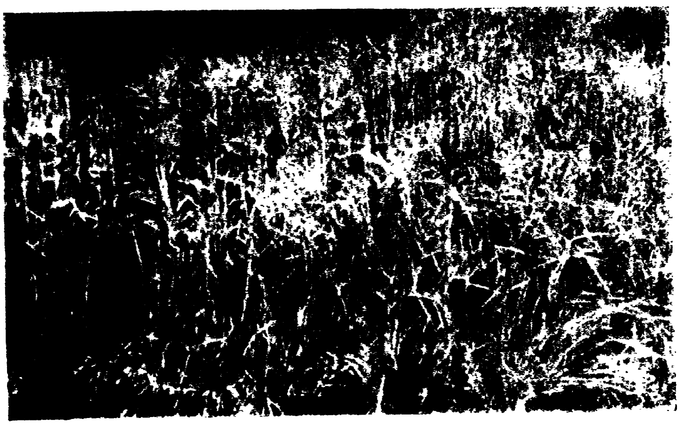
PLATE X.



11. *Alysicarpus rugosus.*

12. *Indigofera linifolia.*

13. *Andropogon contortus*



14. *Ischaemum sulcatum.*

15. *Ischaemum laxum*

indigenous species referred to above. 1/10th acre plots were laid out at Nagpur in which each of them was grown singly and the result observed (Figs. 14-23). The condition of these plots clearly indicated that it is useless to attempt to establish grass-areas by growing a single variety of grass by itself, and that the only way in which it can be done successfully is to grow the various grasses and legumes in a judicious mixture with due regard to differences in their habits of growth, light and soil requirements.

In framing a suitable mixture for the purpose of re-seeding old grazing lands, it must be remembered that the first essential to establish a good sward is to ensure a good "take" and as far as possible to safeguard the appearance of the desired species in the proportions that it is intended they should in fact contribute to the sward. It is obvious that it is impossible to draw up seed mixtures without a knowledge of the powers possessed by the seeds of the several species, not merely for germination but for producing established plants in the soil. From a study of the individual grasses grown in plots as described above, it was possible to devise a suitable mixture which was then grown in 1/10th acre plots.

The results given below show the superiority of such a mixture over the various grasses when grown singly :—

Yield of fodder grasses.

(Lb. per acre.)

	1927		1928		1929		Average	
	Grass	Hay	Grass	Hay	Grass	Hay	Grass	Hay
Mixture of grasses and legumes.	5,300	2,390	9,640	3,850	8,720	4,420	7,886	3,553
Andropogon purpureo-sericeus.	..	..	..	2,755	7,820	3,400	7,820	3,400
Andropogon caricosus	7,600	3,880	6,910	3,325	3,770	1,960	6,093	3,055
Ischaemum sulcatum	6,700	3,430	5,050	2,220	3,860	1,820	5,203	2,490
Ischaemum laxum	5,350	3,730	4,020	2,070	3,740	2,110	4,370	2,636
Apluda varia	3,820	2,140	4,970	2,460	4,220	2,280	4,336	2,293
Andropogon monticola	..	950	3,340	1,915	4,070	1,900	3,705	1,907
Iseilema laxum	3,660	1,680	3,340	1,610	2,130	1,010	3,043	1,433
Andropogon annulatus	..	550	3,454	2,000	1,880	1,140	2,667	1,230
Andropogon pertusus	1,500	840	3,290	1,840	2,200	1,380	2,330	1,353
Andropogon pumilus	2,270	1,000	2,860	1,170	1,810	840	2,313	1,003
Andropogon contortus	5,360	..	4,000	2,080	3,576	1,860	3,788	1,970

It was felt that an attempt to improve the existing grass areas should be made by taking in hand 5-10 acres annually and seeding them down with the above mixture. The results achieved in this direction at Borgaon, Raipur and Nagpur have been very encouraging. They have shown that not only is there an improvement in the composition of the herbage but that spear grass gets gradually suppressed, provided the light cultivation which is necessary before seeding down is given at the proper time, that is to say, if spear grass is cut before the spears have fallen and the land immediately ploughed to prevent secondary growth forming fresh spears.

EXPERIMENTS AT BORGAON.

Ten 1/10th acre plots on the following plan were laid out in duplicate at the Cattle Breeding Farm, Borgaon, with a view to compare and study the effect of different measures outlined below in the eradication and substitution of spear grass :—

Plots 1/10th of an acre in 1½ acre enclosure.

1 Existing grass grazed.

2 Existing grass cut early before spear grass seeds.

3 Existing grass combed before spears have fallen.

4 Check plot cut at normal cutting time for hay.

5 Area cultivated, seeded down with the mixture of grasses and legumes and cut early before spear grass seeds.

6 Area cultivated, seeded down and combed before spears have fallen.

7 Area cultivated, seeded down but more legumes included in the mixture.

8 Area caltivated, seeded down and treated with 5 cwt. of basic slag per acre.

9 Area cultivated and seeded down. The grasses cut at normal cutting time for hay. (Check plot.)

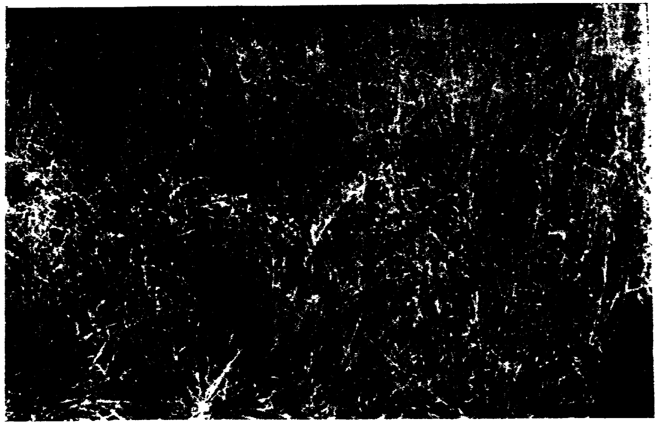
10 Area cultivated, seeded down and grazed.

An accurate analysis of the composition of the original herbage by means of quadrats 6′ 7″ × 6′ 7″ (0·001 acre) disclosed that the vegetation consisted mainly of five species. *Andropogon contortus* and *Andropogon triticeus* were dominant and *Andropogon schoenanthus* sub-dominant, with but few individuals of *Andropogon monticola* and *Andropogon annulatus*, as will be seen from the following :—

Species	No. of culms	Percentage of vegetation
A. triticeus	42	57
A. contortus	24	32
A. schoenanthus	5	7
A. monticola	2	2
A. annulatus	1	1

PLATE XI.

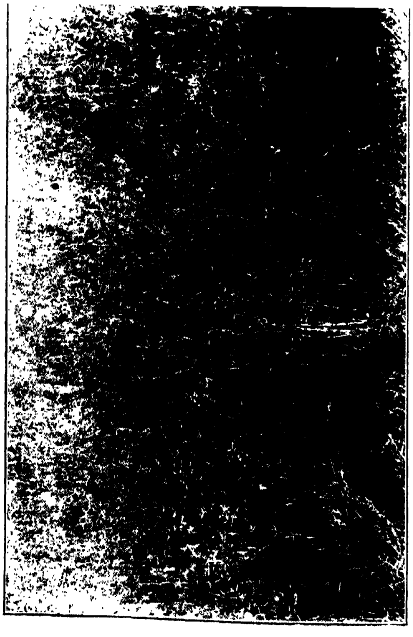
16. *Andropogon purpureo-sericeus.*



17. *Iseilema laxum.*

18. *Andropogon annulatus.*

19. *Andropogon caricosus.*



20. *Andropogon pumilus.*

21. *Andropogon pertusus.*

22. *Andropogon monticola.*

23. *Apluda varia.*

In 1927, six plots of each series were lightly cultivated and seeded down with the mixture of selected grasses and legumes at the commencement of the rains.

Analysis of the vegetation in the re-seeded area made after the rains showed a considerable change in the herbage. *A. caricosus* and *A. annulatus* were now dominant and there was a fairly large proportion of *Ischaemum sulcatum*, *Iseilema laxum* and *Alysicarpus rugosus* ; *A. contortus* and *A. triticeus* had thus disappeared from the re-seeded plots.

The new vegetation was botanically analysed and gave the following composition :—

Species	No. of plants	Percentage of vegetation
A. caricosus and *annulatus*	148	43
Apluda varia	85	24
Iseilema laxum	36	10
Ischaemum sulcatum and *laxum*	6	2
Andropogon pumilus	6	2
Andropogon pertusus	3	1
Alysicarpus rugosus	49	14
Indigofera linifolia	10	3
Tephrosea purpurea	3	1

In 1928 and 1929, the herbage of check plots and re-seeded areas was again analysed and gave the following average composition :—

1928.

Check plot : Vegetation inside a metre quadrat.	No. of plants
Andropogon contortus	6
Andropogon triticeus	5
Andropogon schoenanthus	2
Andropogon pertusus	1
Re-seeded plot : Vegetation inside a metre quadrat.	
Andropogon caricosus	21
Iseilema laxum	16
Andropogon pumilus	15
Andropogon pertusus	13
Ischaemum sulcatum	12
Ischaemum laxum	9
Apluda varia	7
Andropogon monticola	5
Andropogon annulatus	5
Andropogon purpureo-sericeus	3
Alysicarpus rugosus	4

1929.

Check plot : Vegetation inside a metre quadrat.	No. of plants
Andropogon contortus	4
Andropogon triticeus	2
Andropogon schoenanthus	1
Re-seeded plot : Vegetation inside a metre quadrat.	
Ischaemum sulcatum	33
Ischaemum laxum	20
Andropogon pertusus	12
Andropogon pumilus	6
Iseilema laxum	5
Andropogon purpureo-sericeus	4
Andropogon monticola	2
Andropogon annulatus	1
Andropogon caricosus	1
Alysicarpus rugosus	3
Indigofera linifolia	1

It will be seen that the later results confirm the observations made during the first year. *Andropogon contortus*, *A. triticeus* and *A. schoenanthus* continued to be the dominant vegetation in the check plots, whereas in the re-seeded areas the herbage consists of such nutritious and palatable grasses as *Ischaemum sulcatum*, *I. laxum*, *Andropogon annulatus*, *A. pertusus*, *Iseilema laxum*, etc.

Experiments at Chandkhuri.

The site selected for laying out experiments at Chandkhuri consisted almost entirely of spear grass with perhaps a small sprinkling of *Andropogon monticola* and *A. pumilus*. The soil is red and lateritic, locally known as *bhata*, and consists of a slight sprinkling of sandy soil over gravel. The plots after treatment as indicated above gave the following composition :—

1928.

Check plot : Vegetation inside a metre quadrat.	No. of plants
Andropogon contortus	76
Andropogon monticola	26
Re-seeded plot : Vegetation inside a metre quadrat.	
Andropogon pertusus	22
Apluda varia	15
Andropogon pumilus	13
Ischaemum laxum	11
Ischaemum sulcatum	10
Iseilema laxum	10
Andropogon caricosus	6
Andropogon monticola	4
Andropogon contortus	4
Andropogon annulatus	3

1929.

Check plot : Vegetation inside a metre quadrat.	No. of plants
Andropogon contortus	308
Andropogon pumilus	328

(Plants unbranched, with thin solitary stems.)

Re-seeded plot : Vegetation inside a metre quadrat.	
Ischaemum laxum	25
Apluda varia	5
Andropogon pumilus	4
Alysicarpus rugosus	1

(Plants of *Ischaemum sulcatum* were tall and very much branched.)

Though the results achieved at Chandkhuri are not so successful as elsewhere, they, nevertheless, show that by the continuation of the work on slightly altered lines considerable improvement in the herbage from the points of view of variety and yield can be made. The increase of the important grass *Ischaemum laxum* in the re-seeded plots and its extension into the adjoining areas cannot but be considered an improvement over the existing vegetation.

Experiments at Nagpur.

In addition to the experiments conducted on the lines described above, eight 1/20th acre plots were very thickly sown with *Andropogon contortus* in June 1927, and the spears were allowed to fall to the ground with the result that the plots in a very short time contained nothing but spear grass.

The latter is a perennial, erect, leafy grass which is common all over the Central Provinces, and is frequently met with in considerable masses mostly on poor soils. When it is ripe the long awns twist together like the strands of a rope and with the spikelets form conspicuous bunches entangled amongst the stems of the grass (Fig. 13). A great difference of opinion exists regarding the suitability or otherwise of this grass. There is little doubt, however, that it is both less nutritious and less palatable than most other valuable grasses. An analysis of this grass at different stages of growth shows that it is most nutritious in the flowering stage. In this stage, however, appear the awns which are strong and pointed and liable to be injurious to the cattle. To get the best use of the grass as fodder, therefore, it is necessary to cut or graze it before flowering. Experiments have shown that good hay and silage can be made from this grass if it is cut early, *i.e.*, at the flowering time.

These plots then received different treatments in order to find out the best method of eradicating spear grass. Experiments have shown that no useful purpose can be served by burning this grass, as by the twisting movement of the awns,

the seed gets sown sufficiently deep to escape the effects of firing. Cutting early, grazing or combing have proved equally ineffectual in suppressing it.

Cultivating the land in the manner referred to before and then re-seeding with a suitable mixture gave beneficial results and considerable change in the herbage was observed (Figs. 24-27). This can be further seen from the results of the botanical analysis given below :—

1928.

Check plot : Vegetation inside a metre quadrat.	No. of plants
Andropogon contortus (Perennial)	20
Andropogon contortus (Annual)	196
Re-seeded plot : Vegetation inside a metre quadrat.	
Andropogon caricosus	126
Ischaemum sulcatum	56
Apluda varia	22
Andropogon pumilus	22
Andropogon contortus	9
Iseilema laxum	3
Alysicarpus rugosus	6

Conclusions.

A close study of the experiments outlined above leads us to the conclusion that the yield and quality of the herbage of many of our grasslands can be easily and profitably improved if small areas are systematically taken in hand, seeded down and brought under management. The value of fencing the area under treatment can hardly be over-emphasized. It has been observed, in fact, that fencing alone results in better herbage on poor soils, by encouraging such grasses as *Ischaemum laxum* and *Andropogon monticola* to develop and cover the ground. Moreover, the first few years in the life of a newly laid-down grassland are very critical, and it is important that, by means of fencing, excessive grazing and trampling of young seedlings should be prevented to enable the grasses to seed freely and cover the land.

The importance of scientifically-balanced seed mixtures has already been referred to. Not only do plants differ in respect of the demands they make on the soil, but some are light demanding while others are shade-bearing, and this fact must be borne in mind if a good bottom and top covering is to be obtained. Also, some species of herbage are naturally richer in minerals than others. For instance, generally speaking, the legumes are richer than the grasses and are particularly rich in lime. Legumes should therefore be included in the seed mixture.

It has to be admitted that the mere weighing of the produce of green grass or hay from the experimental plots, a chemical or even a botanical analysis of the herbage only tell us half the story, for it takes no account of variations in quality.

24. Check plot (*Andropogon contortus*).

25. Reseeded plot (grasses and legumes).

26. Quadrat (check plot).

27. Quadrat (reseeded plot).

The practised eye can, however, usually tell whether a certain treatment has been effective and even profitable. But to carry conviction, figures are necessary and these can only be obtained by grazing or feeding experiments on animals and then ascertaining the live weight increase. If a sufficient number of animals, carefully selected, are employed, and the experiments carried on for some years, a fair degree of accuracy can be secured.

Sufficient information regarding the effect of manuring our grasslands is not available. There is little doubt, however, that the application of basic slag in our experiments encouraged the spread of *Alysicarpus rugosus* and *Indigofera linifolia*, both leguminous plants of high feeding value. Basic slag or any other kind of phosphate would be useless, however, unless there be a fair supply of leguminous plants present to start with.

Once a grass area has been improved, care must be taken that the improvement is maintained through subsequent years. This can only be done by scientific management, *i.e.*, arranging grazing and cutting on definite scientific lines. Rotational grazing is, in fact, the key to successful grassland management. It is obvious that it is impossible to give concise and specific directions applicable to every conceivable case, but by an intelligent study of the different requirements of grassland according to soil, climate and utilization, etc., one can hope to obtain the best results.

SOME * OF OUR MORE IMPORTANT GRASSES AND LEGUMES.

1. *Ischaemum sulcatum* Hack., vern. *Paona, Paonia.*

A rather short (1-2 ft.), slender, weak, much branched grass with numerous solitary terminal spikes with long awns, the lower half of the awn brown, the upper half almost white. Outer glumes with two nerves on each side of the furrow. Leaves 4-8 inches long, narrow, glabrous, waxy with pointed tips. Sheath loose. Ligule a ciliate ring. Nodes glabrous. (Fig. 1.)

2. *Ischaemum laxum* Br., vern. *Sheda.*

Perennial. Stems slender, 2-3 ft. Leaves narrow, tapering to a fine point, waxy. Ligule a tuft of hairs. Nodes glabrous. Spike single, 2-5 inches long, often slightly curved. Outer glume six-nerved. (Fig. 2.)

3. *Andropogon purpureo-sericeus* Hochst., vern. *Sani baba jara.*

Annual. Stems tall, 3-4 feet erect. Leaves long. Sheath ribbed. Mouth villously silky. Ligule very short, ciliate. Upper nodes villous. Peduncle stout.

* The botanical descriptions are mostly from "The Fodder Grasses of N. India" by J. F. Duthie but other Floras, by T. Cooke, J. D. Hooker, D. O. Witt and R. J. D. Graham, have also been consulted.

Branches in whorles, very slender. Sessile spikelets densely villous with red or white hairs, awned, the lower half dark brown, twisted, the upper half yellow. Very conspicuous when in flowers, the inflorescence having a beautiful red and yellow appearance owing to the stalked spikelets being yellow and hardly hairy, and the sessile spikelets clothed with red brown hairs. (Fig. 3.)

4. *Iseilema laxum* Hack. vern. *Mushyal.*

A slender perennial grass seldom over two feet in height. Stems frequently red. Leaves rather short, 3-6 inches, smooth, often ciliate near the base, base not tuberculated. Ligule membranous, ciliate. Nodes glabrous. Panicle slender, flexuous, usually occupying about half the stem. Branches distant, short, arising from the axils of leaf bracts; the spikelets further enclosed in compressed boat-shaped reddish spathes. (Fig. 4.)

5. *Andropogon annulatus* Forsk., vern. *Lahan marvel.*

A perennial densely tufted grass, 2-3 feet. Stems procumbent at the base, afterwards ascending. Leaves narrow, upper surface with tuberculated hairs, sheaths beared at the top. Nodes hairy. Ligule membranous. Inflorescence of 2-6 terminal spike-like racemes in whorls. Spikelets in many rows, awned, usually purple. (Fig. 5.)

6. *Andropogon caricosus* Linn., vern. *Mothi marvel.*

Perennial. Stems often much branched, grooved on one side, base creeping. Leaves narrow, linear. Sheath compressed, smooth. Ligule a ciliate ridge. Nodes glabrous. Spikes single or in pairs on filiform peduncles. Spikelets more or less in two rows, green with long awns. (Fig. 6.)

7. *Andropogon pumilus* Roxb., vern. *Diwaratan.*

A slender annual grass branching freely. Stems 6-18 inches decumbent below, quite glabrous. Leaves narrow, sheath compressed, keeled, smooth. Inflorescence very characteristic, consisting of numerous pairs of divaricated spikes, tinged with purple or red on a very slender peduncle which arises from a narrow, flattened glabrous spathe. (Fig. 7.)

8. *Andropogon pertusus* Willd., vern. *Kel.*

A sparingly branched, generally erect, slender grass, 1-2 feet high. Nodes bearded with spreading hairs. Leaves long, narrow, hairy at the mouth of the sheath.

Ligule membranous. Inflorescence of 3-8 almost erect, slender, purplish, silky hairy, spike-like racemes. Glume with 1-2 distinct pits. (Fig. 8.)

9. *Andropogon monticola* Schult., vern. *Gada sela.*

Perennial. Stems densely tufted, 1-4 feet high, very slender, erect, leafy at the base. Leaves long, smooth and extremely narrow. Lower sheaths compressed. Ligule very short, ciliate. Nodes glabrous. Peduncle slender. Branches spreading in whorls. Spikelets solitary clothed with yellow hairs. Awns long, twisted in lower portion. (Fig. 9.)

10. *Apluda varia* Hack., vern. *Ponai.*

A tall leafy grass, reddish or green in colour up to five feet in height. Stems much branched, usually rambling among bushes. Leaves long, narrowed from the middle to a filiform tip, and below into a characteristic long or short slender petiole, slightly rough on both surfaces. Ligule membranous toothed. Nodes galbrous. Sheath hairy. Inflorescence of very many solitary small simple spikes clustered on short peduncles and enclosed in a special membranous peduncled spathe. General colour of the inflorescence pale green or purplish. (Fig. 10.)

11. *Alysicarpus rugosus*, vern. *Shevara.*

Stems ascending, nearly glabrous. Leaves 1-foliate, 1-3 inches long, on short hairy petioles, usually oblong, with a subcordate base, obtuse, apiculate, glabrous above, slightly bristly beneath ; stipules longer than the petioles linear-lanceolate, acute, scarious, glabrous. Flowers nearly sessile, in dense spike-like racemes 1-4 inches long, appressed to the subglabrous rachis ; bracts large, chafflike ovate-acuminate. Calyx $\frac{1}{4}$—$\frac{3}{8}$ inches, galbrous on the back ; teeth imbricate, lanceolate, ciliate. Pod included in the calyx, shortly stalked, turgid, apiculate, moniliform ; joints 2-5, broader than long, prominently marked with transverse ribs. (Fig. 11.)

12. *Indigofera linifolia*, vern. *Bhui juar.*

A procumbent persistently silvery-pubescent perennial herb. Stems many, much branched. Leaves simple, $\frac{1}{2}$—1 inch long, sessile or nearly so, usually linear, acute at both ends, mucronate, silvery above and beneath ; stipules minute, setaceous. Flowers 6-12, in very small dense subsessile axillary racemes. Calyx-teeth setaceous, much longer than the tube. Corolla 2-3 times the calyx, bright red or white. Pod minute, globose, 1 seeded, apiculate, silvery-white. Seeds globose, shining. (Fig. 12.)

MINERAL COMPOSITION.

Percentages expressed on 100 parts of dry matter.

	Total ash	Silica free ash	Nitrogen	CaO	P_2O_5	K_2O
1. *Ischaemum sulcatum* .	17·64	2·40	0·58	0·52	0·326	0·50
2. *Ischaemum laxum* . .	17·16	3·56	0·43	0·589	0·223	0·507
3. *Andropogon purpureo-sericeus.*	9·99	3·72	0·57	0·748	0·321	2·13
4. *Iseilema laxum* . .	12·86	2·22	0·464	0·790	0·215	0·875
5. *Andropogon annulatus* .	11·39	2·93	0·539	0·583	0·244	1·40
6. *Andropogon caricosus* .	12·38	2·34	0·334	1·14	0·142	2·36
7. *Andropogon pumilus* .	12·29	7·87	0·816	0·864	0·374	1·39
8. *Andropogon pertusus* .	14·52	3·02	0·643	0·761	0·315	0·941
9. *Andropogon monticola* .	13·00	3·12	0·634	0·870	0·478	0·625
10. *Apluda varia* . .	11·99	4·10	0·675	0·585	0·549	1·16
11. *Andropogon contortus* .	8·88	2·25	0·450	0·446	0·330	0·412
12. Grass mixture . .	18·99	8·08	0·871	3·94	0·310	1·57
13. Good cultivated pastures (England).	9·725	6·97	2·93	1·10	0·765	2·97
14. Poor pastures (not eaten)	..	3·13	1·82	0·30	0·37	1·61

(Figures for items 13 and 14 are taken from the book—" Minerals in Pastures " by J. B. Orr. Others have been obtained from the Agricultural Chemist to Government, Central Provinces.)

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CULTIVATION OF BROOMCORN IN INDIA.*

BY

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In the last paper read at Madras results of successful tests with broomcorn under European, African and American conditions were communicated. These tests have since been continued on a large scale in Algeria with uniformly successful results. Not only has the selectivised hardened Indian seed been found by repeated cultivation to yield the best brush but it has been officially adopted by the Governor General's Agricultural Institute for all future cultivation, to the suppression of all local varieties. Furthermore, extensive plantation of this Indian broomcorn is being undertaken in the region of Bona for the supply of raw material to three factories of brooms and brushes. Also, the cultivation of Indian broomcorn is now to be extended to Tunisia under the auspices of the Agricultural Institute of Sfax.

Encouraged by the good results obtained in the various parts of the world with the Indian broomcorn seed, which have been made available to the farmer in a bulletin (No. 48) published by U. P. Government on the cultivation of broomcorn for which I am deeply indebted to our Chairman, some 26 farms in India have gone in for broomcorn culture. This selectivised seed has been distributed to 7 Government farms, 11 Taluqdars' farms and 8 private farms. The Government farms are in Muttra, Partabgarh, Rae Bareli, Poona, Gwalior, Dharwar and Sholapur. The Taluqdars' farms are mostly in the Rae Bareli District. The private farms are in Allahabad, Cawnpore, Jhansi, Lahore, etc. Thus tests are being made in representative parts of the country.

Results to date are satisfactory on the whole although all the farms have not yet reported. The Government farms in India, as abroad, have done particularly well. The Gwalior farm (1) has raised a very healthy crop sown on 24th August, 1929, with 80 cm. long straight panicles which are suitable for good brooms, brushes, etc. As the area cropped was small, results as regards yield per acre, cost per acre, etc., are not given. I exhibit the brush received.

The Dharwar farm (2) has produced a fairly good crop, sown on 17th August, 1929. The panicle measures 73 cm. but there is curling in some panicles at the base, which is a defect. A brush is exhibited.

The Muttra farm (3) reports that seed sown on 10th August, 1929, showed good germination but after one month's growth the crop was destroyed by locusts. Further tests will be made this year.

The Partabgarh farm (4) tried broomcorn for multiplication of seed only. A 1/10th acre plot was sown on 20th June, 1929. The germination of the plot was

* Paper read at the Indian Science Congress, Allahabad, January 1930.

very good, but growth and outturn was affected, but comparatively less than the *kharif* crops, by the heavy, incessant rain in July and August on the one hand and the long break in August and September. These adverse factors notwithstanding, the plants reached an average height of 10 ft. The crop was harvested in October, yields being as follows :—

Seed—1 md. 17 seers per acre.

Stalks—55 mds. per acre.

The soil was light *dumat*, well-levelled but not manured. The Rae Bareli farm (19) has had good results although crops were damaged by raiding monkeys. Sown on 13th July, 1929, germination on 20th July, 1929, was very good. Average panicle measured 82 cm. The crop was harvested in November with the following yields :—

Seed—18 seers per acre, average height 10 ft.

Stalks—30 mds. per acre.

An intermediate fodder crop was obtained on 9th September, 1929, when all the leaves were lopped and given to cattle.

Results from the remaining Government farms at Sholapur and Poona are still awaited.

The Taluqdars' farms which have not the advantage of expert guidance as the Government farms have obtained some very interesting results.

The Kachaunda farm has yielded the best brush as exhibited. It measures 91 cm. which still falls short of the record of over one meter held by the Governor General's farm in Algeria. The Narekigadhi and Murarmau farms have shown that broom germinates and grows as well in poor sandy soil as in rich loam. The Khajurgaon farm has had very good germination in the minimum of time, 3 days for loam and 4 for sandy soil. These farms have obtained a good supply of seed for further tests.

The private farms have not all reported yet, but one deserves special notice. It has obtained from 10 plants ½ seer of seed grain which is bigger and better than the seed sown. Some of the plants have multiple brushes and one as many as six and when one such brush is harvested another begins to grow *in situ*.

Reviewing all results it is clear that broomcorn cultivation in India has considerable prospects of success (Plate XVI, fig. 2).

How the broomcorn articles compare with the ordinary articles will appear from the following table :—

Broomcorn articles.	Ordinary articles.
1. Brooms—Elastic and strong, do not break or disintegrate in use, as the fibres are naturally bunched together on a central stalk.	1. Brooms of ordinary *Seenk*— (*a*) Very weak and brittle and break easily in use, fibres fall out. (*b*) Brooms of coconut (leaves, midribs), though elastic, harden in use and become brittle afterwards.
2. Chicks—Very smooth and delicate. Can be used for decorating rooms as well as for household purposes when larger chicks are made.	2. Bamboo chicks—are very rough and ugly.

Broomcorn articles.	Ordinary articles.
3. Ropes—Very much smoother and stronger than *munj* ones, and do not prick.	3. *Munj* ropes—are rougher and weaker than broomcorn and prick.
4. Brushes—Purely vegetable fibre brushes of all sorts can only be made from broomcorn fibre at a much cheaper price than 'hair' brushes.	4. Brushes from hair or bristles carry risk of anthrax or other infections. Also, such brushes are open to religious objections from Hindus and Muslims alike.
5. Fans—of broomcorn fibre are much stronger than those of wheat stalks.	5. Fans—of wheat stalks are much weaker as the stalks are hollow.
6. Baskets—of broomcorn fibre are smooth and equally strong as those of *munj*.	6. *Munj* baskets are like those of broomcorn.

It is easy to recognize the superiority of broomcorn articles which form a new cottage industry and help to popularise broomcorn with the peasantry.

SELECTED ARTICLES

PLANT AND SOIL RESEARCH.

The following summary by W. Pugh, of chemical papers discussed in Section M (Agriculture) at the meeting of the British Association in South Africa, is reprinted from the " Journal of the Society of Chemical Industry," Vol. XLVIII, No. 34.]

OPENING the discussion on soil fertility and its control, Sir John Russell, F.R.S., defined a fertile soil as one which satisfies all the conditions of plant growth, adequately supplying plant nutrients, water, warmth, air for the roots, space for the roots, free from undesirable substances or harmful reaction. The supply of plant nutrients affects crop production in two ways. Other conditions being favourable, the amount of plant growth is increased with increasing supply of nutrients up to a certain point. The relationship is not simple : it can be expressed by two factors, one being the minimal amount in the crop of the particular nutrient, and the other the supply of the nutrient already present in the unmanured soil. Some degree of proportionality between the various nutrients is necessary, but there is no evidence that the ratios are narrow. These relationships are much affected by the water supply. In general, nutrients are most effective when there is a good water supply, and the water is most effective when there is a good nutrient supply. A good water supply thus economises the nutrients, and conversely a good nutrient supply economises water. For fruit the relationships are somewhat different, fruiting and growth being in some ways antagonistic. These relationships are important in irrigation practice.

The second way in which nutrients affect the plant is to change its composition, habit of growth, and response to external conditions, including the attacks of insect and fungus pests. So long as the proportion between the different nutrients is such as to give a normal plant, variations in the total amounts have but little effect on composition or habit of growth ; the individual plants may be larger or smaller, but the material of the plant is not much affected. As soon, however, as the proportion of any one element falls too low, certain characteristic effects are produced on the plant, which may profoundly alter its reaction to external conditions, and its chemical composition, and therefore its agricultural value.

In certain conditions any of the elements may thus be in deficiency. Considerable investigation has been made to discover the effects of these deficiencies, and

also their symptoms, so that the agricultural expert might be in a position to recognise them. Large excess of certain of the elements relative to the others also produces characteristic effects, which are being studied.

In humid regions deficiency of nitrogen relative to the other elements is common, the result of the ready solubility of the soil nitrates. This reduces the rate of growth and the total amount of growth, but otherwise has little effect on the composition or character of the plant. Nitrogen deficiency is closely linked with the organic matter content and the micro-biological activity of the soil. In the lecturer's experience it does not occur in dry regions.

Phosphate deficiency may arise anywhere, but especially on soils derived from rocks containing little or no animal remains. It reduces the root activity of plants and the tillering of cereals and brings about certain chemical changes profoundly affecting the quality of the produce. Phosphate starved grass is innutritious to animals, inducing phosphate deficiency diseases which have been much studied by Theiler, du Toit, and Green in South Africa.

Iron deficiency is, perhaps, more common than is usually recognised. B. C. Aston first found it in certain New Zealand soils, and traced it to a persistent anaemia of cattle, from which they suffered greatly, and finally died. This was in a wet region on somewhat acid soil, sufficiently light to allow of ready leaching out of the iron from the surface layer. A similar disease is said to occur elsewhere in similar conditions, and may have the same cause. Unfortunately, no easily recognisable symptoms in the vegetation have been observed, but analysis of the ash at once reveals the deficiency of iron. A like deficiency may occur in dry regions: possibly some of the fertilising effect of sulphur in these conditions may arise from an effect on the iron compounds in the soil.

To manganese deficiency has been attributed a disease of oats, and to magnesium deficiency a chlorosis of tobacco.

Potassium deficiency is usually found only in relation to nitrogen excess. When the ratio of nitrogen to potassium becomes large, the plant is considerably altered: its leaves become very dark green, liable to die in discoloured patches, liable also to attack by certain fungi; the percentage of starch or sugar in the storage organs falls off and the percentage of nitrogen compounds correspondingly increases. The grain of barley suffers in malting quality, the tubers of potatoes suffer in cooking quality, and the roots of sugar beet not only contain less sugar, but yield a more impure juice.

Calcium deficiency is in a different category being closely linked up with the exchangeable bases in the soil, and with the whole body of its physical and chemical properties. It is most liable to occur in wet regions, where it results in an acid soil. It may occur in dry regions, however, especially where sodium chloride is present, and the sodium has displaced some of the calcium. When this replacement has proceeded beyond a certain stage, the properties of the soil are drastically altered making it unsuitable for many agricultural crops. This change is of great impor-

tance in irrigation areas, and it is an important factor in the evil effects of overwatering.

Mr. C. G. T. Morrison discussed some factors controlling soil fertility, dealing with :—Variations in soil composition ; the soil as a succession of changing horizons ; change in horizon character with season ; the content in exchangeable bases, and in degree of saturation of definite horizons varies through the year ; the effect of loss of water upon the pH content of soil suspensions, and upon the exchangeable bases content of the soil ; the possible effect of dehydration upon soil fertility.

In a paper on " Physical factors and their control," Dr. B. A. Keen, Dr. W. G. Ogg, and Prof. N. M. Comber pointed out that the soil moisture is undoubtedly the most important physical factor in plant growth. Measures of control seek, as far as possible, to maintain it at its optimum value, which lies between the deleterious extremes of excess (waterlogging) and deficiency (drought). Methods of soil treatment to encourage rapid drainage of excess water are quite well understood, but there is still very considerable divergence of opinion as to how far it is possible, by appropriate methods of cultivation, to conserve soil moisture in regions of deficient rainfall. It is frequently stated that the preservation of a mulch of dried soil is an effective means of conserving from evaporation the water in the soil below the mulch. On the other hand, extensive work on the influence of moisture on crop production in the Great Plains area of America has led to the conclusion that the loss from a mulched surface is practically the same as from an unmulched one ; the effect of cultivation is to prevent weed growth, and hence transpiration losses, and the mulch is, in fact, only incidental. The theory on which the supposed action of a mulch is based likens the soil to a mass of fine capillary tubes up which water can ascend from the free water table to the surface. The mulch is supposed to break these channels, and thus to prevent water in liquid form from rising higher than the bottom of the mulch. Work at Rothamsted and elsewhere has shown this idea to be incorrect and has also demonstrated that the distance to which water can ascend above the free-water table is much less than that predicted by the laws of capillary rise.

THE ITALIAN RICE INDUSTRY.

[The following article from the *Italian Exporter* is of particular interest, as Italian rice competes with Indian and Burmese rices in the European markets. Though certainly not intrinsically superior to the average run of our rices and doubtless inferior to our best, Italian rices command a higher price in Europe because they are scientifically graded and attractive in appearance. The increase in yield per acre is a striking example of what can be done by the introduction of improved varieties combined with better manuring and better cultivation.]

THE cultivation of rice was first introduced into Italy toward the close of the XVth century when rice was grown to a limited extent in Cicily. In the XVIth century its cultivation had spread to North Italy where it found favourable climatic and agricultural conditions, more especially in the irrigated lands of the provinces of Vercelli, Novara, and Pavia. With the opening in the second half of the XIXth century of the Cavour Canal and the spread of irrigation, the cultivation of rice acquired greater importance, and it became one of the standard crops in Lombardy and Piedmont.

At the present time Italy is by far the largest producer of rice in Europe, and although her contribution to the World's output only amounts to 1/200th, the quality of the paddy and the high nutritive value and fine appearance of dry-dressed Italian rice places the crop among the very best on the market.

AREA AND PRODUCTION.

Although the area planted to rice has fallen considerably during the last forty years, from 238,000 hectares in 1870 to 142,180 in 1927, the yield per hectare has increased steadily and the total output, subject to seasonal variations, shows steady growth over that period.

The following table shows the variations in area and yield since 1870 :—

	1870	1890	1910	1927
Area hectares	238,000	182,000	148,000	142,180
Production, metric tons	148,000	350,000	437,000	696,100
Yield per hectare	0·6	1·9	3·0	4·9

The growth of production is shown by the annual averages for the following decades, expressed in metric tons :—

1884-93	1894-1903	1904-13	1914-27
398,700	399,100	502,491	548,000

In 1927 the crop was distributed as follows between the several rice-growing districts :—

	Hectares	Metric tons
Piedmont	67,760	362,600
Lombardy	65,180	291,500
Emilia	4,535	26,400
Venetia	3,960	13,100
Calabria	300	1,400
Sicily	195	600
Latium	140	200
Tuscany	90	200
Campania	20	100
Total hectares .	142,180	Total metric tons . 696,100

For the five year period 1909-13 the average yield per hectare was 3·2 metric tons of paddy, for the five year period 1923-27 4·4 metric tons.

IMPROVED CULTIVATION.

These results are due to the untiring efforts of the farmers spread over a period of 20 years, assisted by the important work of the extension services and of the agricultural experiment stations, more especially of the renowned Rice Experiment Station at Vercelli.

Finer grades are now produced, yielding rice of uniform size rich in nutritive properties. Measured by Mahler's calorimeter, the *Ostiglia Unhusked* variety contains, for instance, 3,725 calories as compared to 3,794 contained in wholemeal soft wheat ; and recent experiments show that Italian rice is rich in vitamins, phosphates, fats, and proteins and presents, in some varieties in a ratio of over 10 per cent., complete albuminoids. All these facts have secured for it a foremost place on the world's markets.

Effective steps have now been taken to standardise the several qualities of Italian rice, the Ministry of National Economy availing itself for this purpose of the technical services of the Rice Experiment Station at Vercelli, and of the National Export Institute. The breeding of choice varieties of seed is encouraged by prize

competitions in the leading rice-growing districts. Great importance is attached to securing, by careful selection, seed of high-grade purity so as to ensure rice of uniform size, colour, and resistance, and to the use of scientific methods for drying the crop. The experiment station at Vercelli has devoted years of study to this latter desideratum, which has much to do with the successful marketing of the crop, and a well-nigh perfect system has now been introduced which ensures even better results than when the rice is sun-dried.

At the present time, practically all Italian rice plantations of any importance have their drying plants, and the Government provides special credit facilities to enable the farmers to replace out-of-date by improved modern machinery with a capacity in keeping with the rapidly increasing yield per hectare. Among other measures, a conspicuous sum has been assigned by the Ministry of National Economy for the erection, within the current year, of four co-operative drying-plants in the leading rice-growing districts.

At the same time the experiment stations, extension officers and other local authorities are instructed to spare no pains in encouraging the use of choice varieties of selected seed, chemical fertilisers, and machinery for weeding and transplanting, a practice now generally adopted which has greatly increased the yield per hectare.

Cleaning and dressing industry.

In the vicinity of the rice plantations an important rice cleaning and dressing industry has grown up with some 400 establishments.

The output capacity of these establishments varies from 1 to 150 metric tons per day, the majority being equipped for a daily output of from 10 to 20 tons of rice. The total output capacity of the Italian rice industry is estimated at 12,000 tons a year. Practically all the mills are fitted with the most improved and up-to-date machinery, most of which is made in Italy.

The factories are naturally located in the immediate vicinity of the plantations to avoid the cost of transporting the paddy, and are therefore concentrated in Piedmont and Lombardy, with a few plants in the minor rice-growing districts of Venetia and Emilia. The rice mills at present working in Italian sea-ports are those of Fiume, Trieste, and Venice.

Basic conditions all favor this Italian industry, which can avail itself of excellent raw material raised in its immediate vicinity, while its technical equipment is first rate and the capital investment adequate. The industry is thus in a position to produce rice of quality at a minimum cost.

The rice is dressed to meet the tastes and requirements of the several markets, the leading types being oil-dressed (*camolino*), dry-dressed (*raffinato*) and glazed (*brillato*). Subsidiary products of the rice mills are ground rice, starch, and face-powder.

EXPORT TRADE.

The high repute always enjoyed by Italian rice on the world's markets accounts for the importance of the export trade which has very old traditions. The qualities known as "*riso puro Italiano*" or "*Piedmontese rice*" are obtained from varieties which have no difficulty in holding their own in competition with the best of other countries.

The leading markets for paddy are found at Vercelli, Novara, Mortara and Bologna. The export centre for dressed rice is Milan where the most important world term market for rice and paddy has its seat.

Some 300,000 tons of rice are consumed annually on the home market, leaving a large exportable surplus which finds its chief outlet in South America and more especially in Argentina, although large quantities are taken by a whole series of European countries, France, Switzerland, Yugoslavia, Germany, Austria being of special importance. Here, as for other Italian products, the high protectionist policy followed by so many countries since the war interferes with natural trade currents, hindering export to France, Hungary and other countries.

The following table shows the average annual exports of Italian rice for the pre-war period 1911-13 and the rapid growth of the trade in last five years :—

	1911-13	1923	1924	1925	1926	1927
	(Metric tons)					
Austria	13,832	6,271	12,675	13,455	14,874	16,216
Belgium	647	2,614	7,521	4,417	6,835	10,115
France	6,839	23,134	23,956	21,415	22,128	35,773
Germany	483	1,496	7,203	2,476	3,957	19,059
Greece	1,535	4,197	8,806	6,811	11,022	10,902
Yugoslavia	..	8,367	13,441	11,857	16,590	19,360
Switzerland	9,063	11,392	14,943	10,094	14,672	22,440
Hungary	..	1,102	5,663	5,962	7,601	12,782
Argentina	24,999	6,366	33,228	49,622	47,223	48,394
Chile	3,996	939	7,632	8,529	5,966	4,834
Other countries . . .	15,326	20,429	35,495	24,398	20,767	60,163
TOTAL .	76,720	86,307	170,563	159,036	171,637	260,038

Exports are distributed as follows between dressed and undressed rice :—

	1925	1926	1927
	(Metric tons)		
Rice in the husk	95	8	6,180
Loonzeen rice	24,805	32,592	47,471
Dressed rice	134,136	149,073	206,395

The sudden increase in the export of rice in the husk in 1927 is due to the repeal in June of that year of the existing export prohibition.

Subsidiary exports of the rice industry were :—

	1925	1926	1927
	(Metric tons)		
Ground rice	1,643	190	5,126
Starch	1,491	1,109	1,008

Use of the National Export Mark.

To protect foreign importers and Italian exporters against dishonest practices and unfair competition, which has not infrequently taken the form of placing on the market as Italian rice, mixtures of various origins or otherwise adulterated, a law was promulgated in January 1928 establishing official standards and descriptions for home-grown rice for foreign delivery. The outer packings containing such rice must be marked with the appropriate official description and with the National Export Mark established by the act of June 23, 1927. The sacks containing it must be sealed with metal seals stamped with the name and address of the exporter, and with the National Export Mark. The official description of the rice must also appear on all invoices, shipping documents, etc.

Export of rice in the husk, "loonzeen," or dressed rice which do not correspond to the official standard must be marked "rice in the husk", or "loonzeen rice," or "rice on sample." Lots which do not comply with these requirements cannot be shipped from Italy, the railway and customs authorities being instructed to give effect to this provision.

Rice exported under the National Export Mark is sampled by inspectors appointed by the National Export Institute, and analysed to make sure that it possesses the

qualities required. The Control Office is placed under the direction of a Commission consisting of the Director of the Rice Experiment Station of Vercelli as president and a representative respectively of the National Export Institute and of the Rice Exporters. When the rice is found in conformity with the official standard for the description to which it belongs the Control Office delivers a quality certificate to the exporting firm, which affords the guarantee to the importer of the genuine quality of the goods he has purchased.

The use of the National Export Mark in connection with rice which is not up to standard renders the exporter liable to temporary suspension for a period not to exceed six months, or to permanent revocation of the right to use the National Export Mark, thus eliminating from the export market. Offenders are also liable to fines of not less than 500 and not to exceed 10,000 lire for each offence. The unauthorised use of the National Export Mark is severely punished by fines and imprisonment.

Official standards.

In connection with the above law the Ministry of National Economy, by a decree of July 2nd, 1928, determined official standards for home-grown rice.* Twelve basic qualities have been recognised, *i.e.*, 4 Italian "Carolina," 2 Italian "Giant," 6 Italian "Native" (originario). From the two latter, 5 "Giant" and 18 "Native" standards are obtained corresponding to the style of dressing—dry dressed, oiled (*Camolino*), and glazed. The Italian trade can thus provide the foreign buyer with no fewer than 27 guaranteed standards, which amply meet the varied requirements of the consumers.

Samples of these standards have been deposited with the produce exchanges of Genoa, Milan, and Trieste.

The standards and the allowances tolerated are fixed each year by the Vigilance Committee, appointed by the Control Office of the National Export Institute, on the basis of the crop.

The allowances are for weighted percentages.

For the purposes of the official description *first grade cleaning* describes a thorough cleaning of the rice in the husk for the production of the most valued standards of long, large, or round rice.

Second grade cleaning describes a less thorough process than the above, yet such as to give rice ready for glazing.

Dry-dressing describes a process which frees the dehulled rice from all the pericarp down to the albumen. It can be carried to various degrees of thoroughness, *i.e.*, the superficial grade which only removes the pericarp from the carioxide, or the full grade which removes the first stratum of the albumen. For the purposes

* Revised standards came into force on 22nd January, 1930, which will be published in a future issue of the Journal.

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of the official standards now drawn up two grades are recognised, the first corresponding to the full and the second corresponding to the superficial grade.

Oil-dressing (*Camolino*) describes a further process which consists in slightly oiling the surface of the albuminous stratum with linseed oil, castor-oil, or vaseline oil. *Camolino 1* is obtained from first grade dry-dressing, *Camolino 2* from second grade.

Glazing describes a further process in dry-dressing which consists in adding a slight trace of glucose and talcum to impart a sheen to the rice. Here again the degree of glaze corresponds to the degree of dry-dressing. Glazed rice "1" and "2" are obtained from first grade and glazed rice "3" from second grade dressing.

Red streaked describes rice longitudinally streaked a more or less deep red colour.

Big broken rice includes the kinds known as *corpetto* and *mezzagrana*, but excludes *risina* and *puntina*.

Chalky describes rice of opaque, farinaceous appearance due to the fact that it is not thoroughly ripe.

Pitted describes rice with small black spots on the surface which do not injure its food value, rice with slight black streaks or blotches is classed with pitted rice and included in the same allowance.

Ambered describes less transparent, yellowish rice. The following is a list of the 27 official standards of Italian rice for foreign delivery with the official descriptions and allowances so far provided. In all cases the standards apply to sound, honest, merchantable rice, of good average quality for the year, free from impurities, and thoroughly dried.

Italian "Carolina" Standards.

Carolina Sublime Special Standard obtained from the Bertone, Allorio, Novella varieties—first grade cleaning, thoroughly glazed, free from yellow or ambered grain. Allowances: 10 per cent. red streaked; 2 per cent. big broken; 1 per cent. chalky; ½ per cent. pitted or with slight black streaks; 13½ per cent. moisture.

Carolina Sublime Standard obtained from the Allorio, Novella, Greppi, Tolmino, Dallarolle varieties—first grade cleaning, thoroughly glazed, free from yellow or ambered grain. Allowances: 6 per cent. red streaked; 2 per cent. big broken; 1 per cent. chalky; ½ per cent. pitted or with slight black streaks; 13½ per cent. moisture.

Carolina Diamond Standard obtained from the P 6 variety, first grade cleaning, thoroughly glazed, free from yellow or ambered grain. Allowances: 6 per cent. red streaked grain; 2 per cent. big broken; 2 per cent. chalky grain; ½ per cent. pitted or with slight black streaks; 13½ per cent. moisture.

Carolina Vittoria Standard, obtained from the Vittoria variety, first grade cleaning, thoroughly glazed, free from yellow and ambered grain. Allowances: 3 per cent. red streaked; 2 per cent. big broken; 1 per cent, chalky; ½ per cent. pitted or with slight black streaks; 13½ per cent. moisture.

Italian "Gigante" Standards.

Gigante Sublime Oleato obtained from the Vialone variety, second grade cleaning, thoroughly oiled, free from yellow or ambered grain. Allowances: 3 per cent. red streaked; 3 per cent. big broken; 1½ per cent. chalky; ½ per cent. pitted or with slight black streaks; 14½ per cent. moisture.

Gigante Sublime Raffinato obtained from the Vialone variety, first grade cleaning, free from yellow and ambered grain. Allowances: 3 per cent. red streaked; 3 per cent. big broken; 1½ per cent. chalky; ½ per cent. pitted or with slight black streaks; 14 per cent. moisture.

Gigante Extra Brillato obtained from the Maratelli variety, first grade cleaning, thoroughly glazed, free from yellow or ambered grain. Allowances: 2 per cent. red streaked; 3 per cent. big broken; 2 per cent. chalky; ¼ per cent. pitted or with slight black streaks; 14 per cent. moisture.

Gigante Extra Oleato obtained from the Maratelli variety, second grade cleaning, thoroughly oiled, free from yellow or ambered grain. Allowances: 2 per cent. red streaked; 3 per cent. big broken; 2 per cent. chalky; ¼ per cent. pitted or with slight black streaks; 14½ per cent. moisture.

Gigante Extra Raffinato obtained from the Maratelli variety, first grade cleaning, free from yellow or ambered grain. Allowances: 2 per cent. red streaked; 3 per cent. big broken; 2 per cent. chalky; ¼ per cent. pitted or with slight black streeks; 14 per cent. moisture.

Italian "Originario" Standards.

Originario Italiano Splendore Extra Sublime Rice or "*Originario*" *Italiano AAA Rice* obtained from the Chinese *Originario* or other similar varieties, first grade cleaning, thoroughly glazed, free from yellow or ambered grain. Allowances: 2 per cent. red streaked; 2 per cent. big broken; 1 per cent. chalky; ¼ per cent. pitted or with slight black streaks; 13·5 per cent. moisture.

Originario Italiano Splendore Extra Rice obtained from the Chinese *Originario* and other similar varieties, first grade cleaning, thoroughly glazed, free from yellow or ambered grain. Allowances: 2 per cent. red streaked; 7 per cent. big broken; 1½ per cent. chalky; ¼ per cent. pitted or with slight black streaks; 13½ per cent. moisture.

Originario Italiano Splendore Mercantile Rice or *Originario Italiano AA Rice* obtained from the Chinese *Originario* or other similar varieties, first grade cleaning, thoroughly glazed, free from yellow or ambered grain. Allowances: 2 per cent. red streaked; 2 per cent. big broken; 2 per cent. chalky; ¼ per cent. pitted or with slight black streaks; 13½ per cent. moisture.

Originario Italiano Extra Sublime Oleato Rice obtained from the Chinese *Originario* and other similar varieties, first grade cleaning, thoroughly oiled, free

from yellow or ambered grain. Allowances: 2 per cent. red streaked; 2 per cent. big broken; 1 per cent. chalky; ¼ per cent. pitted or with slight black streaks; 13½ per cent. moisture.

Originario Italiano Extra Oleato Rice obtained from the Chinese *Originario* and other similar varieties, first grade cleaning, thoroughly oiled, free from yellow and ambered grain. Allowances: 2 per cent. red streaked; 7 per cent. big broken; 1½ per cent. chalky; ¼ per cent. pitted or with slight black streaks; 13½ per cent. moisture.

Originario Italiano Mercantile Oleato Rice obtained from the Chinese *Originario* and other similar varieties, first grade cleaning, thoroughly oiled, free from yellow or ambered grain. Allowances: 2 per cent. red streaked; 12 per cent. big broken; 2 per cent. chalky; ¼ per cent. pitted or with slight black streaks; 13½ per cent. moisture.

Originario Italian Extra Sublime Raffinato Rice obtained from Chinese *Originario* and other similar varieties, first grade cleaning, free from yellow and ambered grain. Allowances: 2 per cent. red streaked; 2 per cent. big broken; 1 per cent. chalky; ¼ per cent. pitted or with slight black streaks; 13½ per cent. moisture.

Originario Italiano Extra Raffinato Rice obtained from the Chinese *Originario* and other similar varieties, first grade cleaning, thoroughly oiled, free from yellow or ambered grain. Allowances: 2 per cent. red streaked; 7 per cent. big broken; 1½ per cent. chalky; ¼ per cent. pitted or with slight black streaks; 13½ per cent. moisture.

Originario Italiano Mercantile Raffinato Rice obtained from the Chinese *Originario* and other similar varieties, first grade cleaning, thoroughly oiled, free from yellow and ambered grain. Allowances: 2 per cent. red streaked; 2 per cent. big broken; 1 per cent. chalky; ¼ per cent. pitted or with slight black streaks; 13½ per cent. moisture.

Originario Italiano Splendore Fino Superiore Rice obtained from the Chinese *Originario* and other similar varieties, second grade cleaning, well glazed, free from yellow grain. Allowances: 3 per cent. red streaked; 2 per cent. big broken; 2 per cent. chalky; 1 per cent. pitted or with slight black streaks; ¼ per cent. ambered; 14 per cent. moisture.

Originario Italiano Splendore Fino Rice obtained from the Chinese *Originario* and other similar varieties, second grade cleaning, well glazed, free from yellow grain. Allowances: 3 per cent. red streaked; 7 per cent. big broken; 2½ per cent. chalky; 1 per cent. pitted or with slight black streaks; ¼ per cent. ambered; 14 per cent. moisture.

Originario Italiano Splendore Corrente Rice obtained from the Chinese *Originario* and other similar varieties, second grade cleaning, well glazed, free from yellow grain. Allowances: 3 per cent. red streaked; 12 per cent. big broken; 3 per cent. chalky; 1 per cent. pitted or with slight black streaks; ¼ per cent. ambered; 14 per cent. moisture.

Originario Italiano Fino Superiore Oleato Rice obtained from the Chinese *Originario* and other similar varieties, second grade cleaning, well oiled, free from yellow grain. Allowances: 3 per cent. red streaked; 2 per cent. big broken; 2 per cent. chalky; 1 per cent. pitted or with slight black streaks; ¼ per cent. ambered; 14 per cent. moisture.

Originario Italiano Fino Oleato Rice obtained from the Chinese *Originario* and other similar varieties, second grade cleaning, well oiled, free from yellow grain. Allowances: 3 per cent. red streaked; 7 per cent. big broken; 2½ per cent. chalky; 1 per cent. pitted or with slight black streaks; ¼ per cent. ambered; 14 per cent. moisture.

Originario Italiano Corrente Oleato Rice obtained from the Chinese *Originario* and other similar varieties, second grade cleaning; well oiled, free from yellow grain. Allowances: 3 per cent. red streaked; 12 per cent. big broken; 3 per cent. chalky; 1 per cent. pitted or with slight black streaks; ¼ per cent. ambered; 14 per cent. moisture.

Originario Italiano Fino Superiore Raffinato Rice obtained from the Chinese *Originario* and other similar varieties, second grade cleaning, free from yellow grain. Allowances: 3 per cent. red streaked; 2 per cent. big broken; 2 per cent. chalky; 1 per cent. pitted or with slight black streaks; ¼ per cent. ambered; 14 per cent. moisture.

Originario Italiano Fino Raffinato Rice obtained from the Chinese *Originario* and other similar varieties, second grade cleaning, well oiled, free from yellow grain. Allowances: 3 per cent. red streaked; 7 per cent. big broken; 2½ per cent. chalky; 1 per cent. pitted or with slight black streaks; ¼ per cent. ambered; 14 per cent. moisture.

Originario Italiano Corrente Raffinato Rice obtained from the Chinese *Originario* and other similar varieties, second grade cleaning, well oiled, free from yellow grain. Allowances: 3 per cent. red streaked; 12 per cent. big broken; 3 per cent. chalky; 1 per cent. pitted or with slight black streaks; ¼ per cent. ambered; 14 per cent. moisture.

The National Export Institute will reply to all enquiries addressed to it either by home producers and exporters or by foreign importers. Enquiries should be clear and precise, describing the articles to which they refer, the requirements of the correspondent, the demands of the market, and any other particulars which may be called for.

Address all enquiries to Instituto Nazionale Per L'esportazione, *Via* Torino, 107, Roma (105). Telegraphic address, Esportare, Roma. Telegraphic Codes: Marconi, A. B. C. 5th Imp. and 6th Ed., Bentley.

OFFICIAL STANDARDS FOR AMERICAN RICE.

[American rices fetch higher prices than Indian and Burma rices on the European market not by virtue of any intrinsic superiority, but because they are scientifically graded and attractively packed. The official standards were notified in September 1927 and the following description is taken from the "Hand Book of Official Standards for Milled Rice, Brown Rice and Rough Rice" published by the Bureau of Agricultural Economics, United States Department of Agriculture, January 1928.]

By virtue of the authority vested in the Secretary of Agriculture by the act of Congress entitled "An act making appropriations for the Department of Agriculture for the fiscal year ending June 30, 1928, and for other purposes," approved January 18, 1927 (Public No. 522, 69th Cong.) I W. M. Jardine, Secretary of Agriculture, do hereby fix, establish, and promulgate the following standards of class, quality, and condition for Milled Rice, Brown Rice, and Rough Rice, which shall become the official standards of the United States for the inspection and certification of such rices on the 15th day of September, 1927, and be in force and effect as long as Congress shall provide the necessary authority therefor, unless amended or superseded by standards hereafter prescribed and promulgated under such authority.

In testimony whereof I have hereunto set my hand and caused the official seal of the Department of Agriculture to be affixed, in the city of Washington, this 6th day of September 1927.

W. M. JARDINE,
Secretary.

U. S. Standards for Milled Rice.

For the purposes of the United States standards for milled rice :

Milled rice. Milled rice shall be whole or broken kernels of rice grown in continental United States, from which the hulls and practically all of the germs and bran layers have been removed, which may be either coated or uncoated, and which does not contain more than 10 per cent. of cereal grains including paddy grains, seeds, or other foreign material, either singly or in any combination.

HONDURAS MILLED RICE (CLASS I).

This class shall include the rices known commercially as Honduras and Mortgage Lifter, which contain more than 25 per cent. of whole kernels, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

Edith Milled Rice (Class II).

This class shall include the rice known commercially as Edith, which contains more than 25 per cent. of whole kernels, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

Fortuna Milled Rice (Class III).

This class shall include the rice known commercially as Fortuna, which contains more than 25 per cent. of whole kernels, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

Carolina Milled Rice (Class IV).

This class shall include the rices known commercially as Carolina and Storm Proof, which contains more than 25 per cent. of whole kernels, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

Lady Wright Milled Rice (Class V).

This class shall include the rice known commercially as Lady Wright, which contains more than 25 per cent. of whole kernels, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

Grade requirements for the classes Honduras, Edith, Fortuna, Carolina, and Lady Wright milled rice.

Grade	Maximum limits of—						
	Cereal grains, seeds, and heat damage (number in 500 grams)		Red rice and damage other than heat (singly or combined)	Chalky kernels	Broken kernels		Other rices
	Total	Heat damage and seeds (singly or combined)			Total	Through No. 6 sieve	
	No.	No.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Extra Fancy (U. S. No. 1)	3	1	0·5	1·0	10	0·3	1
Fancy (U. S. No. 2)	7	4	1·5	1·5	15	·5	2
Extra Choice (U. S. No. 3)	12	7	2·0	2·0	20	·7	4
Choice (U. S. No. 4)	18	10	2·5	3·0	25	1·0	6
Medium (U. S. No. 5)	40	25	6·0	6·0	35	2·0	10

Sample grade.—Sample grade shall be milled rice of the classes Honduras, or Edith, or Fortuna, or Carolina, or Lady Wright, respectively, which does not come within the requirements of any of the grades from Extra Fancy (U. S. No. 1) to Medium (U. S. No. 5), inclusive, or which has any commercially objectionable

foreign odor, or is musty or sour, or is heating or hot, or is of a badly damaged or extremely red appearance, or is otherwise of distinctly low quality, or contains more than 0·1 per cent. of foreign material excepting paddy grains, other cereal grains, and seeds.

The percentage of moisture in the grades Extra Fancy (U. S. No. 1), Fancy (U. S. No. 2), Extra Choice (U. S. No. 3), Choice (U. S. No. 4), and Medium (U. S. No. 5) shall not exceed 14·5.

Color and general appearance.—Rice of the grade Extra Fancy (U. S. No. 1) shall be white or creamy and shall be well milled. Rice of the grade Fancy (U. S. No. 2) shall be white, creamy, or grayish and shall be well milled. Rice of the grade Extra Choice (U. S. No. 3) shall be white, creamy, or grayish, and shall be reasonably well milled. Rice of the grade Choice (U. S. No. 4) shall be white, creamy, or grayish, and may be slightly rosy, and shall be reasonably well milled. Rice of the grade Medium (U. S. No. 5) may be of slightly damaged or red appearance.

Blue Rose Milled Rice (Class VI).

This class shall include the rices known commercially as Blue Rose, Greater Blue Rose and Improved Blue Rose, which contain more than 25 per cent. of whole kernels and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

Early Prolific Milled Rice (Class VII).

This class shall include the rice known commercially as Early Prolific, which contains more than 25 per cent. of whole kernels and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

Grade requirements for the classes Blue Rose and Early Prolific milled rice.

Grade	Maximum limits of—						
	Cereal grains, seeds, and heat damage (number in 500 grams)		Red rice and damage other than heat (singly or combined)	Chalky kernels	Broken kernels		Other rices
	Total	Heat damage and seeds (singly or combined)			Total	Through No. 6 sieve	
	No.	No.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Extra Fancy (U. S. No. 1) . .	3	1	0·5	1·0	5	0·3	1
Fancy (U. S. No. 2) . . .	7	4	1·5	1·5	10	·5	2
Extra Choice (U. S. No. 3) . .	12	7	2·0	2·0	15	·7	4
Choice (U. S. No. 4) . . .	18	10	2·5	3·0	20	1·0	6
Medium (U. S. No. 5) . . .	40	25	6·0	6·0	25	2·0	10

Sample grade.—Sample grade shall be milled rice of the classes Blue Rose or Early Prolific, respectively, which does not come within the requirements of any of the grades from Extra Fancy (U. S. No. 1) to Medium (U. S. No. 5), inclusive, or which has any commercially objectionable foreign odor, or is musty or sour, or is heating or hot, or is of a badly damaged or extremely red appearance, or is otherwise of distinctly low quality, or contains more than 0·1 per cent. of foreign material, excepting paddy grains, other cereal grains, and seeds.

The percentage of moisture in the grades Extra Fancy (U. S. No. 1), Fancy (U. S. No. 2), Extra Choice (U. S. No. 3), Choice (U. S. No. 4) and Medium (U. S. No. 5) shall not exceed 14·5.

Color and general appearance.—Rice of the grade Extra Fancy (U. S. No. 1) shall be white or creamy and shall be well milled. Rice of the grade Fancy (U. S. No. 2) shall be white, creamy, or grayish, and shall be well milled. Rice of the grade Extra Choice (U. S. No. 3) shall be white, creamy, or grayish, and shall be reasonably well milled. Rice of the grade Choice (U. S. No. 4) shall be white, creamy, or grayish and may be slightly rosy and shall be reasonably well milled. Rice of the grade Medium (U. S. No. 5) may be of slightly damaged or red appearance.

Japan Milled Rice (Class VIII).

This class shall include the rices known commercially as Japan, which contain more than 25 per cent. of whole kernels, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes. This class shall be divided into two sub-classes : (*a*) Japan milled rice and (*b*) California-Japan milled rice.

Sub-Class (A) Japan Milled Rice.

This sub-class shall include all rices known commercially as Japan, possessing the characteristics of rice of this class as grown east of the Rocky Mountains.

Grade requirements for the sub-class Japan milled rice.

Grade	Maximum limits of—						
	Cereal grains, seeds, and heat damage (number in 500 grams)		Red rice and damage other than heat (singly or combined)	Chalky kernels	Broken kernels		Other rices
	Total	Heat damage and seeds (singly or combined)			Total	Through No. 6 sieve	
	No.	No.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Extra Fancy (U. S. No. 1)	3	1	0·5	2·0	5	0·3	1
Fancy (U. S. No. 2)	7	4	1·5	4·0	10	·5	2
Extra Choice (U. S. No. 3)	12	7	2·0	6·0	15	·7	4
Choice (U. S. No. 4)	18	10	2·5	8·0	20	1·0	6
Medium (U. S. No. 5)	40	25	6·0	10·0	35	2·0	10

Sample grade.—Sample grade shall be milled rice of the sub-class Japan milled rice, respectively, which does not come within the requirements of any of the grades from Extra Fancy (U. S. No. 1) to Medium (U. S. No. 5), inclusive, or which has any commercially objectionable foreign odor, or is musty or sour, or is heating or hot, or is of a badly damaged or extremely red appearance, or is otherwise of distinctly low quality, or contains more than 0·1 per cent. of foreign material excepting paddy grains, other cereal grains, and seeds.

The percentage of moisture in the grades Extra Fancy (U. S. No. 1), Fancy (U. S. No. 2), Extra Choice (U. S. No. 3), Choice (U. S. No. 4), and Medium (U. S. No. 5) shall not exceed 14·5.

Color and general appearance.—Rice of the grade Extra Fancy (U. S. No. 1) shall be white or creamy and shall be well milled. Rice of the grade Fancy (U. S. No. 2) shall be white, creamy, or grayish, and shall be well milled. Rice of the grade Extra Choice (U. S. No. 3) shall be white, creamy, or grayish, and shall be reasonably well milled. Rice of the grade Choice (U. S. No. 4) shall be white, creamy, or grayish, and may be slightly rosy, and shall be reasonably well milled. Rice of the grade Medium (U. S. No. 5) may be of slightly damaged or red appearance.

Sub-Class (B) California-Japan Milled Rice.

This sub-class shall include all rices known commercially as Japan, possessing the characteristics of rice of this class as grown west of the Great Plains area of the United States.

Grade requirements for the sub-class (b) California-Japan milled rice.

Grade.	MAXIMUM LIMITS OF—						
	CEREAL GRAINS, SEEDS, AND HEAT DAMAGE (NUMBER IN 500 GRAMS)		Red rice and damage other than heat (singly or combined)	Chalky kernels	BROKEN KERNELS		Other rices.
	Total	Heat damage			Total	Through No. 6 sieve	
	No.	No.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Extra Fancy* (U. S. No. 1)	3	0	0·2	2·0	5	0·3	0·2
Fancy (U. S. No. 2)	7	2	·5	4·0	10	·5	·4
Extra Choice (U. S. No. 3)	12	3	1·0	6·0	15	·7	1·0
Choice (U. S. No. 4)	18	5	1·5	8·0	20	1·0	3·0
Medium (U. S. No. 5)	25	7	2·0	10·0	25	2·0	5·0

* The grade Extra Fancy shall contain no cereal grains other than paddy grains and may contain not more than one mud lump.

Sample grade.—Sample grade shall be milled rice of the sub-class California-Japan milled rice, which does not come within the requirements for any of the grades

from Extra Fancy (U. S. No. 1) to Medium (U. S. No. 5), inclusive, or which has any commercially objectionable foreign odor, or is musty or sour, or is heating or hot, or is of a badly damaged or extremely red appearance, or is otherwise of distinctly low quality, or contains more than 0·1 per cent. of foreign material excepting paddy grains, other cereal grains, and seeds.

The percentage of moisture in the grades Extra Fancy (U. S. No. 1), Fancy (U. S. No. 2), Extra Choice (U. S. No. 3), Choice (U. S. No. 4), and Medium (U. S. No. 5) shall not exceed 14·5.

Color and general appearance.—Rice of the grade Extra Fancy (U. S. No. 1) shall be white or creamy and shall be well milled. Rice of the grade Fancy (U. S. No. 2) shall be white, creamy or grayish, and shall be well milled. Rice of the grade Extra Choice (U. S. No. 3) shall be white, creamy, or grayish, and shall be reasonably well milled. Rice of the grade Choice (U. S. No. 4) shall be white, creamy, or grayish, and may be slightly rosy, and shall be reasonably well milled. Rice of the grade Medium (U. S. No. 5) may be of slightly damaged or red appearance.

Second Head Milled Rice (Class IX).

This class shall consist of milled rice which contains not more than 25 per cent. of whole kernels, not more than 50 per cent. of broken kernels which will pass readily through a 6½ sieve, and not more than 10 per cent. of broken kernels which will pass readily through a No. 6 sieve.

Grade requirements for the class Second Head milled rice.

Grade	Maximum limits of—					
	Cereal grains, seeds, and heat damage (number in 500 grams)		Red rice and damage other than heat (singly or combined)	Chalky kernels	Broken kernels	
	Total	Heat damage and seeds (singly or combined)			Through No. 6 sieve	Through No. 6½ sieve
	No.	No.	P. ct.	P. ct.	P. ct.	P. ct.
Extra Fancy (U. S. No. 1)	20	15	1	3	3	15
Fancy (U. S. No. 2)	25	20	2	5	5	25
Extra Choice (U. S. No. 3)	40	35	4	10	7	35
Choice (U. S. No. 4)	60	50	6	15	10	50
Medium (U. S. No. 5)	110	100	10	20	10	50

Sample grade.—Sample grade shall be milled rice of the class Second Head which does not come within the requirements of any of the grades from Extra Fancy (U. S. No. 1) to Medium (U. S. No. 5), inclusive, or which has any commercially objectionable foreign odor, or is musty or sour, or is heating or hot, or is of a badly

damaged or extremely red appearance, or is otherwise of distinctly low quality, or contains more than 0·1 per cent. of foreign material, excepting paddy grains, other cereal grains, and seeds.

The percentage of moisture in grades Extra Fancy (U. S. No. 1), Fancy (U. S. No. 2), Extra Choice (U. S. No. 3), Choice (U. S. No. 4) and Medium (U. S. No. 5) shall not exceed 14·5.

Color and general appearance.—Rice of the grades Extra Fancy (U. S. No. 1), Fancy (U.S. No. 2) and Extra Choice (U. S. No. 3) shall be white, creamy, or grayish. Rice of the grade Choice (U. S. No. 4) may be of slightly damaged or slightly rosy appearance. Rice of the grade Medium (U. S. No. 5) may be of slightly damaged or red appearance.

SCREENINGS MILLED RICE (CLASS X)

This class shall consist of milled rice which contains not more than 25 per cent. of whole kernels, which does not meet the requirements of size separations specified for the class Second Head milled rice, and which contains not more than 15 per cent. of broken kernels which will pass readily through a No. 5½ sieve. This class shall be divided into two sub-classes : (*a*) Screenings milled rice and (*b*) California-Japan Screenings milled rice.

Sub-class (A) Screenings Milled Rice.

The sub-class shall include all Screenings milled rice possessing the characteristics of rice of this class as grown east of the Rocky Mountains.

Grade requirements for the Sub-class Screenings Milled Rice.

Grade	MAXIMUM LIMITS OF—			
	Cereal grains and seeds (number in 500 grams)	Chalky kernels	BROKEN KERNELS	
			Through No. 5½ sieve	Through No. 6 sieve
	No.	Per cent.	Per cent.	Per cent.
Extra Fancy (U. S. No. 1)	20	5	4	20
Fancy (U. S. No. 2)	50	8	6	30
Extra Choice (U. S. No. 3)	90	12	8	40
Choice (U. S. No. 4)	140	20	10	50
Medium (U. S. No. 5)	250	30	15	60

Sample grade.—Sample grade shall be milled rice of the sub-class Screenings milled rice which does not come within the requirements of any of the grades from Extra Fancy (U. S. No. 1) to Medium (U. S. No. 5), inclusive, or which has any commercially objectionable foreign odor, or is musty or sour, or is heating or hot,

or is of a badly damaged or extremely red appearance, or is otherwise of distinctly low quality, or contains more than 0·1 per cent. of foreign material, excepting paddy grains, other cereal grains, and seeds.

The percentage of moisture in grades Extra Fancy (U. S. No. 1), Fancy (U. S. No. 2), Extra Choice (U. S. No. 3), Choice (U. S. No. 4), and Medium (U. S. No. 5) shall not exceed 14·5.

Color and general appearance.—Rice of the grades Extra Fancy (U. S. No. 1) and Fancy (U. S. No. 2) shall be white, creamy, or grayish. Rice of the grade Extra Choice (U. S. No. 3) shall be white, creamy, or grayish, and may be slightly rosy. Rice of the grade Choice (U. S. No. 4) may be of slightly damaged or rosy appearance. Rice of the grade Medium (U. S. No. 5) may be of damaged or red appearance.

NOTE.—The grade term "Medium" (U. S. No. 5) for the sub-class Screenings milled rice corresponds to the grade term F. A. Q. "Screenings," heretofore commonly used commercially.

Sub-class (B) California-Japan Screenings Milled Rice.

This sub-class shall include all Screenings milled rice made from the rice known commercially as Japan, possessing the characteristics of rice of this class as grown west of the Great Plains area of the United States.

Grade requirements for the sub-class California-Japan Screenings milled rice.

Grade	Maximum limits of—			
	Cereal grains and seeds (number in 500 grams)	Chalky kernels	Broken kernels	
			Through No. 5½ sieve	Through No. 6 sieve
	No.	Per cent.	Per cent.	Per cent.
Extra Fancy (U. S. No. 1)	30	5	4	20
Fancy (U. S. No. 2)	75	8	6	30
Extra Choice (U. S. No. 3)	125	12	8	40
Choice (U. S. No. 4)	175	20	10	50
Medium (U. S. No. 5)	250	20	10	50

Sample grade.—Sample grade shall be milled rice of the sub-class California-Japan Screenings milled rice which does not come within the requirements of any of the grades from Extra Fancy (U. S. No. 1) to Medium (U. S. No. 5), inclusive, or which has any commercially objectionable foreign odor, or is musty or sour, or is heating or hot, or is of a badly damaged or extremely red appearance, or is otherwise of distinctly low quality, or contains more than 0·1 per cent. of foreign material, excepting paddy grains, other cereal grains, and seeds.

The percentage of moisture in grades Extra Fancy (U. S. No. 1), Fancy (U. S. No. 2), Extra Choice (U. S. No. 3), Choice (U. S. No. 4), and Medium (U. S. No. 5) shall not exceed 14·5.

Color and general appearance.—Rice of the grades Extra Fancy (U. S. No. 1), Fancy (U. S. No. 2), Extra Choice (U. S. No. 3), and Choice (U. S. No. 4) shall be white, creamy, or grayish. Rice of the grade Medium (U. S. No. 5) may be slightly damaged or slightly rosy.

Brewers Milled Rice (Class XI).

This class shall consist of milled rice which contains not more than 25 per cent. of whole kernels and contains more than 15 per cent. of broken kernels which will pass readily through a No. 5½ sieve. This class shall be divided into two sub-classes : (*a*) Brewers milled rice and (*b*) California-Japan Brewers milled rice.

Sub-class (A) Brewers Milled Rice.

This sub-class shall include all Brewers milled rice possessing the characteristics of rice of this class as grown east of the Rocky Mountains.

Grade requirements for the sub-class Brewers milled rice.

Grade	Cereal grains and seeds (maximum limits)		Color and general appearance
	Number in 500 grams	Percentage	
	No.	Per cent.	
Extra Fancy (U. S. No. 1)	60	..	White, creamy, or grayish.
Fancy (U. S. No. 2)	..	0·1	Ditto.
Extra Choice (U. S. No. 3)	..	·2	White, creamy, or grayish and may be slightly rosy.
Choice (U. S. No. 4)	..	·4	May be of slightly damaged or rosy appearance.
Medium (U. S. No. 5)	..	1·5	May be of damaged or red appearance.

Sample grade.—Sample grade shall be milled rice of the sub-class Brewers milled rice which does not come within the requirements of any of the grades from Extra Fancy (U. S. No. 1) to Medium (U. S. No. 5), inclusive, or which has any commercially objectionable foreign odor, or is musty or sour, or is heating or hot, or is of a badly damaged or extremely red appearance, or is otherwise of distinctly low quality, or contains more than 0·1 per cent. of foreign material excepting paddy grains, other cereal grains, and seeds.

The percentage of moisture in grades Extra Fancy (U. S. No. 1), Fancy (U. S. No. 2), Extra Choice (U. S. No. 3), Choice (U. S. No. 4) and Medium (U. S. No. 5) shall not exceed 14·5.

Note—The grade term Medium (U. S. No. 5) for the sub-class Brewers milled rice corresponds to the grade term " Standard Milled-Run Brewers " heretofore commonly used commercially.

Sub-class (B) California-Japan Brewers Milled Rice.

This sub-class shall include all Brewers milled rice made from the rices known commercially as Japan, possessing the characteristics of rice of this class as grown west of the Great Plains area of the United States.

Grade requirements for the sub-class California-Japan Brewers milled rice.

Grade	Cereal grains and seeds (maximum limits)	Color and general appearance
	Per cent.	
Extra Fancy (U. S. No. 1)	0·5	White, creamy, or grayish.
Fancy (U. S. No. 2)	1·0	Ditto.
Extra Choice (U. S. No. 3)	1·5	Ditto.
Choice (U. S. No. 4)	3·0	May be slightly damaged or slightly rosy.
Medium (U. S. No. 5)	5·0	May be damaged or rosy.

Sample grade.—Sample grade shall be milled rice of the sub-class California-Japan Brewers milled rice which does not come within the requirements of any of the grades from Extra Fancy (U. S. No. 1) to Medium (U. S. No. 5), inclusive, or which has any commercially objectionable foreign odor, or is musty or sour, or is heating or hot, or is of a badly damaged or extremely red appearance, or is otherwise of distinctly low quality, or contains more than 0·1 per cent. of foreign material excepting paddy grains, other cereal grains, and seeds.

The percentage of moisture in grades Extra Fancy (U. S. No. 1), Fancy (U. S. No. 2), Extra Choice (U. S. No. 3), Choice (U. S. No. 4) and Medium (U. S. No. 5) shall not exceed 14·5.

Grades for Mixed Milled Rice.

Mixed milled rice.—Mixed milled rice shall be a mixture of any two or more of Classes I, II, III, IV, V, VI, VII, and VIII, which does not meet the requirements of any one of such classes.

Mixed milled rice shall be graded according to each of the grade requirements common to the class or sub-class of the milled rice which predominates over each other class or sub-class in the mixture, except that all of the grade requirements in any class as to the maximum percentages of other rices shall be disregarded. The grade designation of mixed milled rice shall include, successively, in the order named, the name of the grade, or the number thereof, the word "Mixed," and, in the order of its predominance, the name and approximate percentage of each class or sub-class of milled rice which constitutes 10 per cent. or more of the mixture; but if only one class or sub-class exceeds 10 per cent. of the mixture, the name and approximate percentage of that class or sub-class shall be added to the grade

designation followed by the name and approximate percentage of at least one other class or sub-class.

GRADES FOR COATED MILLED RICE.

Coated milled rice.—Coated milled rice shall be milled rice which has been coated with glucose and talc or any other substance.

Coated milled rice shall be graded and designated according to the grade requirements of the grades applicable to such rice if it were not coated, and there shall be added to and made a part of such grade designation the word " Coated."

GRADES FOR WEEVILY MILLED RICE.

Weevily milled rice.—Weevily milled rice shall be milled rice in which adult live weevils or other insects injurious to stored rice, or their larvae, or clusters of webby material are found in a number exceeding 1 in 500 grams of milled rice.

Weevily milled rice shall be graded and designated according to the grade requirements of the grades applicable to such rice if it were not weevily, and there shall be added to and made a part of such grade designation the word " Weevily."

DEFINITIONS.

Basis of determinations.—Each determination of cereal grains, seeds, or other foreign material, heat-damaged kernels, temperature, odor, live weevils, or other insects injurious to stored rice, moisture content, and general appearance shall be made on the basis of the grain including foreign material. All other determinations shall be made on the basis of the grain when free from foreign material.

Percentages.—Percentages, except in the case of moisture, shall be percentages ascertained by weight.

Percentage of moisture.—Percentage of moisture shall be that ascertained by the moisture tester and the method of use thereof described in Bulletin 1375, dated February, 1926, issued by the United States Department of Agriculture, Bureau of Agricultural Economics, or ascertained by any device and method giving equivalent results.

No. 5½ sieve.—A metal sieve perforated with round holes five and one-half sixty-fourths inch in diameter.

No. 6 sieve.—A metal sieve perforated with round holes six sixty-fourths inch in diameter.

No. 6½ sieve.—A metal sieve perforated with round holes six and one-half sixty-fourths inch in diameter.

Damaged kernels.—Damaged kernels shall be kernels and pieces of kernels of milled rice which have been distinctly damaged by water, insects, or by any other means. Sound double and sound broken kernels shall not be considered damaged kernels.

Heat-damaged kernels.—Heat-damaged kernels shall be kernels and pieces of kernels of milled rice which have been distinctly discolored by external heat or as a result of heating caused by fermentation.

Cereal grains.—Cereal grains shall include paddy grains (rough rice), barley, wheat, rye, emmer, spelt, einkorn, corn, grain sorghums, and oats, and shall not include buckwheat, flaxseed, and wild oats.

Seeds.—Seeds shall be grains, kernels, or seeds, either whole or broken, of any plant other than rice or cereal grains.

Red rice.—Red rice shall be kernels or pieces of kernels of milled rice which are distinctly red in color or have any appreciable amount of red bran thereon.

Broken kernels.—Broken kernels shall be split kernels of milled rice and pieces of kernels which are less than three-fourths of the length of the perfect kernel.

Chalky kernels.—Chalky kernels shall be kernels and pieces of kernels of milled rice one-half or more of which is chalky.

(*To be continued.*)

NOTES

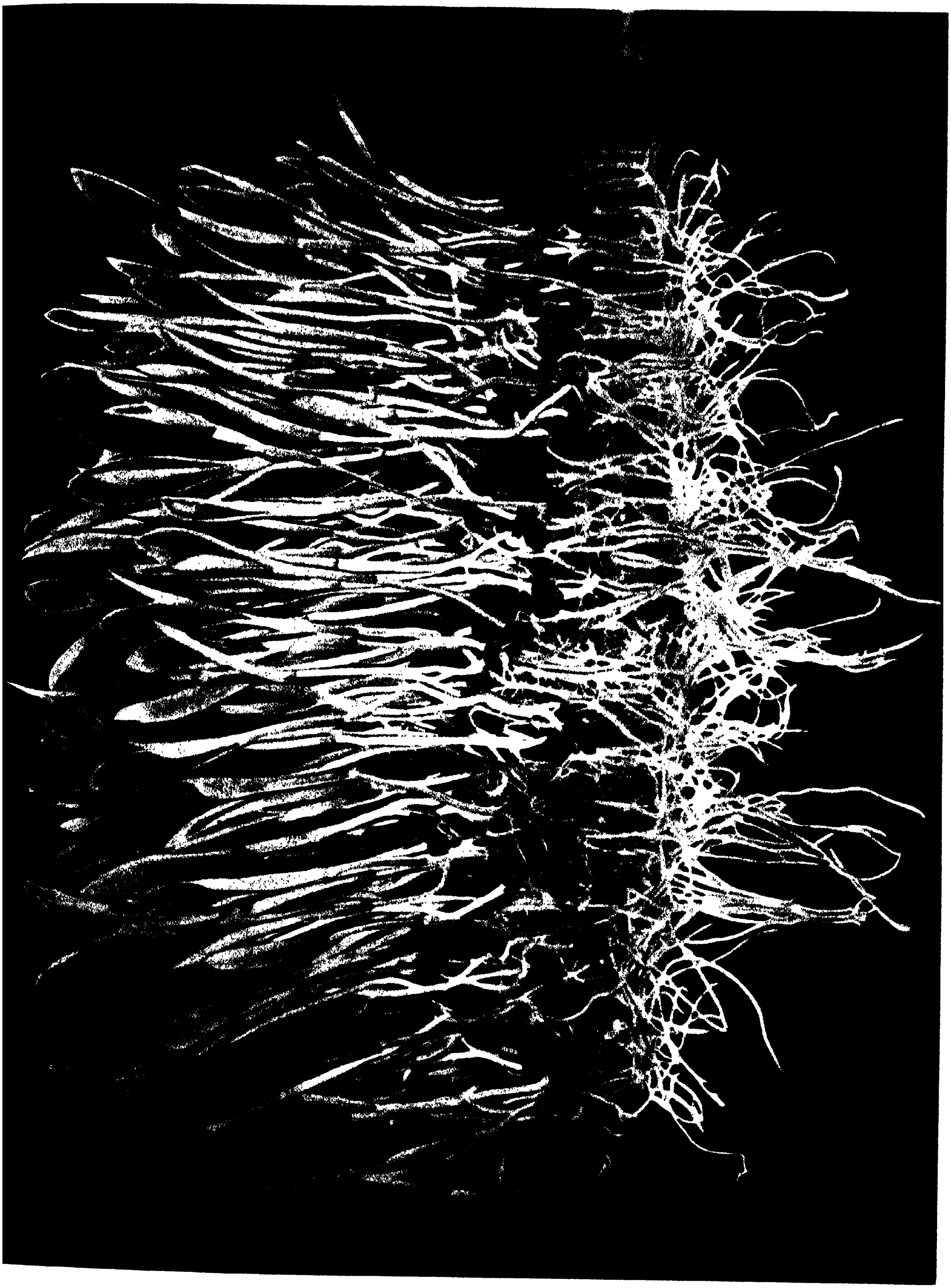
A GRAPHIC METHOD OF PRESENTING SIMPLE MENDELIAN SEGREGATION.

THE study of heredity along Mendelian lines is becoming a feature of applied botany, and Colleges of Science and of Agriculture give prominence to genetics. To a student, often in urban surroundings, the usual demonstration of a simple Mendelian segregation is too often the familiar figures of the text-books. To the fortunate few that are in touch with the Agricultural Department in its plant-breeding wing, it is given to see these segregations in plenty.

At the Millets Breeding Station, Coimbatore, working on certain families in *Eleusine coracana* throwing albinos, some mature earheads beaten down by rain and wind on moist earth, started germinating in continued wet weather and gave rise to masses of seriate seedlings, some all green and others a mixture of green and white. Pursuing this clue a number of plants were straight away picked out as heterozygous and homozygous. Albinism is not a common occurrence, though I believe with my experience in rice, *ragi*, sorghum, Italian millet and bulrush millet, it is likely to be common enough in breeding stations where a mass of seed of varying origin is mobilised, and radically different characters get into an impact with each other.

If albinism is not so familar, a simple segregation for purple pigmentation is a common enough experience. An earhead of sorghum, the first generation head of a cross between purple and green, was selected and germinated. The head was split lengthwise and one half was laid flat in wet sand. After a few days, a mass of seedlings sprouted, and a gentle washing with a spray of water took off all the sand and left the germinated seedlings, both purple and green, sticking on to the earhead intact. Parallel to this might be germinated the two parental earheads showing a mass of pure green and pure purple seedlings; and the three earheads thus germinated would present in a most graphic way what segregation is. It is virtually detecting segregation in a plot in a tabloid form.

Albinism and pigmentation apart, the marked manner in which seedlings differ from each other in their first leaves, could also be utilized to prove their segregation, though to a beginner this exhibit may not carry the ocular demonstration which purple and green or green and white easily give. The material selected need not be confined to sorghum or *ragi* illustrated in this note (Plates XIV and XV), but can



Andropogon Sorghum—Green and Albino Seedlings

Eleusine coracana—Green and Albino Seedlings.

PLATE XVI.

Fig. 1. Broomcorn with five brushes.

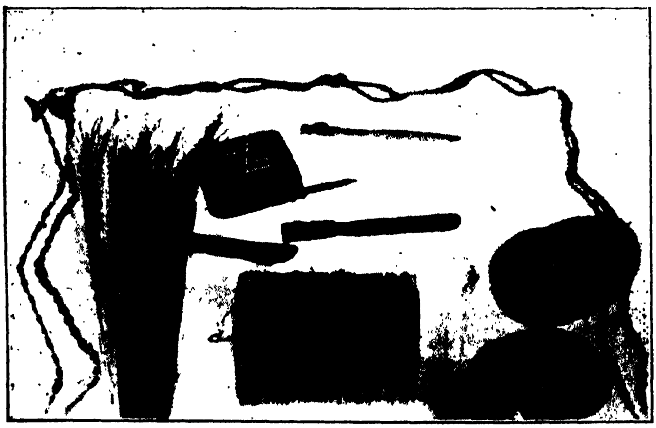


Fig. 2. Numerous uses to which the fibre can be put.

easily be any other compact earheads such as *Setaria italica* and *Pennisetum typhoideum*. These earheads can be germinated, after a slight soaking in water, on wet blotting paper.

When educational institutions desire to have material for demonstrations of the kind indicated, they might get into touch with the nearest plant-breeding centre, which would only be too glad to give practical proof of the widely felt desire for a closer co-ordination between teaching and research. [G. N. RANGASWAMI AYYANGAR.]

BROOMCORN WITH FIVE BRUSHES.

BROOMCORN is a variety of sorghum (*juar*) which differs from other species in having panicles and seed-heads with much longer, straighter and stronger branches. It is known to botanists as *Andropogon Sorghum* var. *technicum* and is grown in Southern Europe and America. It belongs to the grass family and to the same species as do common sorghums, used for making syrup, and Kaffir corn and Jerusalem corn, grown for forage and for grain. The standard type grows to a height of 10 to 15 feet and produces a brush from 18 to 28 inches long.

In a sample of Italian broomcorn " brush " a few seeds were discovered by accident and formed the starting point of a series of tests. The first series of tests showed that broomcorn can grow under the most varied and adverse conditions with extraordinary facility. It yielded sufficient stock of seed for field experiments on a larger scale.

The second series of field tests were also surprisingly successful. About half a maund of seed, possessed of a high degree of selectivity, and capable of rearing a very strongly resistant plant, was obtained.

This improved seed was distributed to some 25 farms in the country. In one farm* at Allahabad the plants have done very well and produced a most abnormal type with 5 brushes instead of only one as shown in the accompanying plate (Plate XVI, fig. 1). Some plants have got 3 brushes and each is heavy with corn and seed heads. One has got 6. The seeds obtained are bigger than those sown.

The greatest advantage is that birds cannot eat the corn after these are ripe since the brushes droop with weight. The farmer has not to watch his field.

Hundreds of parrots used to sit on these plants but none could be eaten by them. After a time the birds ceased to come. The corn has been liked by villagers and taken to introduce it in their villages.

Plate XVI, fig. 2 shows the numerous uses to which the fibre can be put: (1) broom, (2) brushes of several kinds, (3) rope, (4) chick, (5) fan, (6) basket, etc. [S. S. NEHRU.]

* By courtesy of Mr. U. C. Mukerji, Assistant Commissioner of Excise, Allahabad, U. P.

COTTON NOTES.

The following abstracts have been received for publication from the Secretary, Indian Central Cotton Committee:—

SEED COTTON: LINT INDEX, GINNING PERCENTAGE, AND EFFECTS OF ENVIRONMENT. COTTON HAIR: UNIT WEIGHT. A. J. Turner. (*J. Text. Inst.*, 1929, 20, T233-T274.)

THE relative merits of ginning percentage and lint index for representing the amount of lint borne on a single cotton seed are discussed, and the work of Leake, Balls, and Burd is critically reviewed. It is concluded that the lint index cannot be measured only by the number of fibres per seed, and that from the number of variables appearing in the equation for ginning percentage, no direct proportionality ought to be expected between the ginning percentage and the number of fibres per seed, or any other single property, whether volume of seed or unit fibre-weight. These conclusions are confirmed by an examination of the available data, including many new results obtained for various Indian cottons. The conclusions of Balls that outturn fluctuations are due to differences in the environmental conditions on the day of flowering, and that the number of epidermal cells which sprout into hairs is determined by such differences, are examined and shown to be of doubtful tenability; it appears more probable that lint hairs continue to be differentiated after the day of flowering. From Balls' experimental results it appears that the weight of lint per unit area of seed-surface is practically constant for different sizes of seed, and that this almost completely accounts for the fact that smaller seeds have a higher ginning percentage. Whereas Balls' view necessitates that the smaller seeds should each have a greater total number of fibres, it is shown that if the product of fibre-strength and fibre-length is taken as a measure of unit fibre-weight, higher ginning percentage is more generally associated with a smaller number of fibres per seed. However, neither the total number of fibres per seed nor the number of fibres per unit area of seed-surface is directly proportional to the seed-weight or to the ginning percentage, so that these results do not enable a decision to be made as to whether or not the differentiation of all the lint cells takes place on the day of flowering, and the influence of the environment on this differentiation. The results of studies of the ginning percentage of individual seeds of the Bengal cotton, Aligarh A. 19, and of Punjab-American 4F. are given. Actual determinations of fibre-weight confirm the above conclusions. Various methods of determining the weight of a single fibre are discussed. From an examination of the various possibilities in the development of lint on the seed, it is concluded that the fibre-weight per unit length may differ for different lengths of fibre, and that a general tendency may exist for the shorter fibres to have a rather greater fibre-weight per unit length. Results are given for certain Indian cottons which confirm these conclusions. A method of determining the average number of fibres of each group-length per seed

is described, and the results so far published for the number of fibres per seed of different varieties of cotton are summarised. [*British Cotton Industry Research Association—Summary of Current Literature*, Vol. IX, No. 19.]

COTTON BOLLWORMS: CONTROL. S. C. Harland. (*Empire Cotton Gr. Rev.*, 1929, 6, 333-334.)

Different species and varieties of cotton vary in their palatability to bollworms. Apparently the moths are led to lay their eggs most abundantly on the plants with the most attractive odour. It is suggested that a possible method of control lies in the employment of certain hybrids as a trap-crop. Hybrids between New World and Old World cottons have been made by several workers which are characterised by complete sterility. Flowers are produced abundantly but since the pollen and ovules are non-functional, the young bolls are invariably shed in a week or less. It follows that the larvæ of species of bollworm which require older bolls to complete their development will perish in the shed bolls. In the case of the Pink Bollworm, almost full-grown larvæ have occasionally been seen in the open flower, but practically no breeding up can take place. Another hybrid—that between *G. Sturtii*, the Wild Australian species, and New World types—is also available for trap-crops. [*British Cotton Industry Research Association—Summary of Current Literature*, Vol. IX, No. 20.]

COTTON PLANT: GROWTH. S. A. Kudrin. *Chem. Abs.*, 1929, 23, 4998 (from *Z. Pflanzenernähr., Düngung u. Bodenk.*, 1929, 13A, 91-93).

The cotton plant was studied as to the fresh weight of material produced, air-dried weight of material produced, absolute dry weight of material produced, and chemical composition at five stages of growth—(1) with the formation of the third leaf, (2) bud formation, (3) bloom stages, (4) the beginning of ripening, (5) the first harvest. The chemical studies showed a decrease of the relative amounts of nitrogen and ash constituents with increasing age. The largest amounts of nitrogen and phosphorus were found in the blooms and seeds, while the largest amounts of calcium and magnesium were found in the leaves and stems. With increasing plant growth the nitrogen and ash constituents migrate from the vegetative to the generative organs. In the last stages of development investigated (the first harvest stage) two-thirds of the total nitrogen and phosphorus compounds of the cotton plant were in the generative organs, while the larger part of the calcium remained in the vegetative organs. The magnesium in this stage was more or less equally divided in both classes of organs. Between the bud formation and bloom formation stages, the cotton plant absorbed the largest amounts of nutrients from the soil. During this time an increased absorption of calcium and nitrogen compared with phos phorus and magnesium occurred. The cotton plant has a high requirement for nutrients, but it so happens that the large quantities of these nutrients are not

removed with the harvest of the cotton but are returned to the soil. [*British Cotton Industry Research Association—Summary of Current Literature*, Vol. IX, No. 23.]

PRELIMINARY NOTES ON THE CONTROL OF LOCUSTS (*Schistocerca gregaria*). E. Harrison. (*Bull. Dept. Agr., Kenya*, 1929. Abstr. from *Rev. App. Ent.*, Ser. A, Pt. 8, 1929, p. 474.)

It is suggested that locusts (*Schistocerca gregaria*, Forsk.) do not always invade Kenya from the outside, but they may live in the solitary form in Tanaland, the Northern Frontier Province, or in Tanganyika Territory.

Experiments showed that contact spraying with a solution of 5 to 6 oz. of sodium arsenite to 4 gallons of water was most effective, both against hoppers and the freshly-moulted adults. Dusting with sodium arsenite by means of perforated tins was also effective. Spraying the vegetation was tried with varying success, and poisoned baits also gave good results.

A NOTE ON THE USE OF DRIED POISON BAIT AGAINST LOCUSTS IN THE SUDAN. H. H. King. (*Bull. Ent. Res.*, XX, 1, 1929. Abstr. from *Rev. App. Ent.*, XVII, Ser. A, Pt. 9, 1929, p. 507.)

Unskilled natives were found incapable of using a spraying machine effectively, or of mixing poison bran bait properly for effecting the control of locusts, and experiments, therefore, were carried out to find a bait that could be issued ready for use. One that had been sun-dried and only required moistening with water was tested during the winter of 1927-28 and during the rainy season of 1928, and reports on the results obtained were universally favourable. The stock solution is prepared by dissolving 168 lb. commercial sodium arsenite (80 per cent. As_2O_3) in water, and making the solution up to 22 gallons; to this is added 92 gallons molasses. This stock solution is diluted in the proportion of 1 part by volume to 17 parts water, so that 9 gallons dilute solution contain 1 lb. sodium arsenite. In preparing the bait, the bran is heaped on a cement floor and dilute poison added at the rate of 12 gallons to 100 lb. The bran is thoroughly stirred until it is uniformly moist; it is then spread out to dry in the sun and subsequently passed through a coarse sieve to remove any lumps. The dried bait is put up in bags each containing approximately 9¼ lb., and the bags packed eight in a sack. One gallon of water is required to moisten the contents of one bag. The bait should be stirred in until evenly moist, left for ten minutes to absorb the water and become soft, and then broadcast thinly in the path of the hoppers. The bait has been found in good condition after storing for ten months. The molasses makes it more attractive and delays its drying up.

This bait has also been used with success against the larvæ of *Agrotis ipsilon*, Hufn.

Pink Bollworm (*Platyedra gossypiella*, Saund.) in the Gezira District of the Sudan in 1927 and 1928. H. B. Johnston. (*Bull.* No. 26, *Ent. Sect. Welcome Trop. Res. Lab., Sudan, 1929.*)

The years 1927 and 1928 were marked by a higher rate of infestation by pink bollworm in the Gezira cotton crop. An average of 3·8 per cent. was observed in 1927, and 24·1 per cent. in 1928. In view of this increase a determined effort was made by means of legislation, propaganda, and house-to-house search, to obtain as much as possible of such seed as would neither be exported from the district directly after ginning nor be treated by sunning, and it is believed that a very large proportion of this seed was destroyed. Investigations on samples from various sources showed no living larvæ in seed which had been exposed to high temperature in the open, but seed from buildings produced larvæ in the majority of cases. It is probable that the majority of these living larvæ were of the short-cycle generation, and that the number of long-cycle moths produced in the Gezira is small. It is considered that the best means of killing all resting larvæ is to sun the seed at 62°C. for two hours.

A new, simple, and rapid method for determining the moisture equivalent of soils, and the role of soil colloids on this moisture equivalent. G. J. Bouyoucos. (*Soil Sci.*, XXVII, 3, 1929. Abstr. from *Int. Rev. of Agr.*, XX, 7, 1929, p. 260.)

A new method of determining the "moisture equivalent" of soils, based on elimination of the water by diminution of pressure in place of centrifugal force, and giving more certain results, which reveal a close correlation between the "moisture equivalent" and the rate of colloidal substances in the soils. A photograph is given of the apparatus employed.

"Combed peeler" and "Peeler comber" Cotton: definition. (*Text. World* [U. S.], 76, 1929. Abstr. from *Summ. of Curr. Lit.*, IX, 15, 1929, E. 22.)

The terms "combed peeler" and "peeler comber," as loosely used at present, refer in the first case to any combed American cotton, and in the second to the waste of any combed American cotton. The word "Delta" is still being used by the trade synonymously with "peeler". The correct definition of all American cotton other than American Egyptian or Pima, and Sea Island, is Uplands. The only accurate specification of the latter is by length and grade, although $\frac{7}{8}$ inch and shorter cotton is usually defined as short cotton, longer than $\frac{7}{8}$ inch and up to $1\frac{1}{8}$ inches as premium cotton, and $1\frac{1}{8}$ inches and longer Uplands as extra staples. The term "peeler" originally applied to what are now known as "extra staples," "combed peeler" being this cotton after combing, and "peeler comber" being the waste of such cotton.

[*The Empire Cotton Growing Review*, Vol. VII, No. 1.]

Personal Notes, Appointments and Transfers, Meetings and Conferences, etc.

The sub-station of the Imperial Institute of Veterinary Research at Izatnagar will in future be designated " Imperial Veterinary Serum Institute". The designation of the Officer-in-charge, *viz.*, Third Veterinary Research Officer, is changed to " Deputy Director ".

MR. P. N. RAJGOPAL, M.A., Indian Audit and Accounts Service, has been appointed Personal Assistant to the Director, Imperial Institute of Veterinary Research, Muktesar.

DR. W. BURNS, D.Sc., Officiating Director of Agriculture, Bombay, has been granted combined leave for four months and 12 days with effect from 7th June, 1930.

MR. T. F. MAIN, O.B.E., B.Sc., Director of Agriculture, Bombay, has been granted an extension of leave on half average pay for three months.

MR. D. L. Sahasrabudhe, M.Ag., M.Sc., Agricultural Chemist to Government of Bombay, has been granted leave on average pay for two months with effect from 17th April, 1930.

MAJOR P. B. RILEY, M.R.C.V.S., Offg. Director of the Civil Veterinary Department, Bihar and Orissa, has been granted leave on average pay for seven months with effect from 27th April, 1930.

MR. T. J. EGAN, M.R.C.V.S., Superintendent, Civil Veterinary Department, North Punjab, has been granted combined leave for 10 months with effect from 11th December, 1929.

Mr. S. I. A. SHAH, M.R.C.V.S., has been appointed officer in charge of the duties of Superintendent, Civil Veterinary Department, North Punjab, *vice* Mr. EGAN granted leave.

Mr. R. Watson, N.D.A., Deputy Director of Agriculture, Burma, has been posted to the charge of the East Central Circle, *vice* Mr. A. McLean on leave.

U Kyaw Zan, B.A., Assistant Director of Agriculture, Burma, has been placed in charge of the Arakan Circle, *vice* Mr. R. Watson transferred.

Major R. F. Stirling, F.R.C.V.S., D.V.S.M., F.Z.S., Offg. Director of Veterinary Services, Central Provinces, has been granted combined leave for ten months and four days with effect from 22nd March, 1930.

Captain W. H. Priston, F.R.C.V.S., Superintendent, Civil Veterinary Department, United Provinces, whose services have been placed at the disposal of the Central Provinces Government, has been appointed to officiate as Director of Veterinary Services, Central Provinces, *vice* Major Stirling granted leave.

Rao Bahadur Tundi Lal Pawar, B.A., has been appointed Deputy Director of Agriculture in the Field Experiment and Extension Branch of the Central Provinces Agricultural Service, Class I, with effect from 24th November, 1929.

Mr. W. Harris, M.R.C.V.S., Superintendent, Civil Veterinary Department, Assam, has been granted combined leave for six months and fiften days with effect from 15th April, 1930. Babu Guru Prasanna Sen will be in charge of the department during the absence of Mr. Harris.

REVIEWS

Sisal : Production and Preparation—Edited and brought up to date by H. Hamel Smith. Pp. xxx +384 ; illus. (London : John Bale, Sons and Danielsson, Ltd.) Price, 21*s.* net.

Mr. Hamel Smith has done a great service to sisal planters in compiling a volume containing information culled from all the important sisal producing countries in the world. The author, and Dr. Mann, who contributes a foreword to the book, both comment on the lack of progress in the knowledge of the sisal plant and its behaviour, and the reader will find how diverse opinions are, when comparing statements regarding costs of production and yields from different countries. All types of soil are recommended as being most suitable for the crop, from the poorest to the richest, but there is unanimity on one point,—that the land be well drained.

It is contended by some that arid soils give a leaf with high fibre content, whilst rich soils produce a fleshy leaf with little fibre. A perusal of the various reports leads one to the conclusion that sisal adapts itself to poor soils, but for commercial success a good soil is required.

The need or otherwise of cultivation is another bone of contention ; but there is no question that in tropical or sub-tropical countries clean land is essential, otherwise the crop has to compete with jungle for its very existence.

The " suckers *versus* bulbils " dispute is a hardy annual amongst all sisal growers, but suckers seem to win the day as they require no nursery and can be transplanted directly on to the land.

Yields per acre vary in reports from half a ton to 2½ tons. With fibre at £35 a ton this means a variation in gross revenue of from £17-10 to £87-10 per acre. The latter reads like the inducement in a bucket shop prospectus. A plantation averaging ¾ of a ton of fibre per acre would appear to be getting a satisfactory extraction.

Apart from the usual factors such as soil, cost of land, labour, etc., which affect all plantation crops alike, the critical factor with sisal is the length of life of the plant and the number of cuttings possible in its life time. Here again there is great disparity in the reports. In Kenya the life of the plant is said to be 9 years and 6 years productive: Mann and Hunter estimated for Assam a life of 10 to 12 years with 7 to 9 years productive : in Cuba 12 to 20 years is said to be the life of the plant, whilst in Yucatan plants of 20, 25, 30 and even 60 years of age are mentioned by Dodge.

It is evident that there is much room for investigation by the plant breeder and it is significant that throughout the book no reference is made to botanical research.

At Dacca the length of life of the plant has been considerably increased by selection from late maturing stock.

It has often been urged that sisal would be a remunerative crop for the Indian ryot. It is true that the fibre is extracted in the Philippines by retting but in all other countries mechanical extraction is the rule. Outside the jute-growing districts scarcity of water precludes retting. The central factory system might apply in India but the capital involved is heavy from the point of view of the small cultivator. A plant capable of dealing with 30 acres costs Rs. 8,500, whilst one to deal with 2,500 acres costs Rs. 1,62,500. In either case, provided the cultivator produces the crop and lands the leaf at the factory, a profit of about Rs. 70 per acre would be available for division between the factory authorities and the cultivator, with sisal selling at £35 a ton. These figures are based on an estimate from Kenya, the average yield being taken at half a ton per acre.

It must be remembered that the cultivator would have to wait four years for any return from his land, a contingency which in the majority of cases he would not be able to meet.

The author lays great stress on the possibility of reducing costs by the production of alcohol as a bye-product. Definite information on the subject is lacking, but a point that has to be taken into consideration is the enormous advance that has been made with crude oil engines. The prices of lighter fuels must fall if they are to compete as power producers. [K. McL.]

An important **monograph on pectic substances** prepared by Dr. M. H. Branfoot (neé Carré), of the Botany Department of the Imperial College of Science and Technology, for the Food Investigation Board of the Department of Scientific and Industrial Research has been published by His Majesty's Stationery Office.* Dr. Carré herself has carried out a number of detailed investigations on the pectins and the present publication will be of value to all students of the subject.

The first four chapters discuss the chemistry of the pectic compounds. Then follow three chapters on methods of extraction, preparation and estimation of these substances. Chapters VIII and IX deal with the location and distribution of the pectic compounds in plant tissues and their possible functions in the plant economy, while chapter X describes the changes which these compounds undergo in fruits, with special reference to the apple. Attention is drawn to the phenomenon, as evidenced by investigations, both chemical and microscopical, that the series of progressive changes in the pectic compounds distributed in the cell framework is intimately associated with the gradual metabolic drift from the maturity of the

* "A Critical and Historical Study of the Pectic Substances of Plants", by M. H. Branfoot (M. H. Carré), D.I.C., D.Sc., Department of Scientific and Industrial Research, Food Investigation Special Report No. 33, London, published under the authority of His Majesty's Stationery Office, 1929.

apple to the final stages of senescence. In fact it may be stated with a considerable degree of assurance that the stage of maturity of the fruit can be ascertained by micro-chemical examination of the tissues alone. And similar examinations of fruits other than the apple also show that although slight differences may occur, an analogous sequence of pectic changes is typical of the various stages of ripening and death.

The next chapter gives an account of the enzymes responsible for the pectic changes observed in certain plant and fruit structures. The chpater which follows describes the action of fungi and bacteria on the pectic substances. Here the important subjects, *viz.*, the decomposition of pectic compounds by organisms associated with the retting of textile fibres and the changes in pectic substances brought about by organisms responsible for various plant diseases are dealt with. The last chapter is concerned with another item of practical importance, *viz.*, the formation of pectin-sugar fruit jellies. A historical account of this subject is followed by a critical discussion of the factors which determine jelly formation. An excellent bibliography adds greatly to the value of the book.

Dr. Branfoot has rendered considerable service by her present publication, as, during recent years, the study of these compounds has become of considerable importance in connection with several economic problems. Pectic changes are involved in such dissimilar processes as storage of fruits and vegetables, the setting of jams and jellies, fermentation process in the manufacture of wine, beers and cider, the retting of fibre plants such as flax and hemp, the isolation of starch from wheat and potatoes, and the preparation of wood pulp used in the manufacture of paper, etc.

A reference may be permitted to the probability that the nature of the pectic substances contained in plant residues influences the sequence of changes brought about by soil micro-flora and may thus determine the course of humification.
[J. S.]

The Land of the Five Rivers—An economic history of the Punjab from the earliest times to the year of Grace 1890—by HUGH KENNEDY TREVASKIS, M.A., O.B.E., I.C.S. (Oxford University Press.)

All students of Indian economics and indeed all who are interested in agricultural matters from whatever standpoint will be grateful to Mr. Trevaskis for his very readable account of the agrarian history of the Punjab from the days of the nomads until 1890. They will also look forward to the promised companion volume which will bring that history up to date for, as the author himself is careful to point out, modern conditions had hardly been fully established by 1890 and the Punjab had not then reached the proud position which it now occupies. As is perhaps inevitable in a work dealing with a period of over 4,000 years, the authorities quoted are mainly modern commentators and there has been no critical examination of contemporary

literature even where such is available in considerable quantity. Hence the student of particular periods should read with discrimination; this is specially true of the Moghul and early British periods. The two chapters on the "Political supremacy of the Lawyer" and the "Economic Dictatorship of the Money-lender" are really separate essays in which the author has departed considerably from the historical method and where his interpretation of the position at the end of the nineteenth century will not be universally acceptable. But he puts forward views which deserve careful consideration though all his readers will not share his aversion to landlords and to enclosures. It may at once be admitted that the conversion of the Punjab peasantry into a body of landed proprietors rapidly led to some very difficult problems, not the least of which was the abuse of a suddenly enlarged credit by a body of agriculturists enjoying a new-found security of land tenure and of property but as yet not educated to wise spending and to the use of credit for development. Nor have these problems yet been solved entirely. But it is at least open to argument whether there was in fact any alternative open but to recognize private ownership of land and it has still to be shown that a body of peasant proprietors is not a sound system of agricultural organization for a densely populated province. The inadequacy of finance for agricultural operations is a grave problem throughout the world and, in our existing social system, the lack of tangible assets by the small farmer is one of the greatest difficulties met with. It may yet prove that the early British rulers of the Punjab builded even better than they knew. For the general reader the book has decided attractions. As the natural link between Central Asia and India, the Punjab played a dominating part in Indian history and its early history is in some respects the history of civilization in miniature; the constant swing of the pendulum between tribal and village organization is well brought out and the effect of successive invasions from Central Asia is clearly explained. The book should help many to "See life steadily and see it whole". [B. C. B.]

Report of the Food Investigation Board for the year 1928.—Published by His Majesty's Stationery Office for the Department of Scientific and Industrial Research. Price, 3*s*. 6*d*.

The various investigations undertaken and which are mainly financed by the Empire Marketing Board deal with every phase in the storage and transport of food materials including meat, fruits and vegetables, and cover such an extremely wide range that it is impossible to summarise them within the scope of a review. Of most interest to readers in India will be the results of bio-chemical and physiological studies of fruit and vegetables.

In their bio-chemical study of senescence in apples, Onslow, Kidd and West have extended the results obtained in 1925-26 by Haynes and Archbold on the effect of chemical composition on keeping quality. The further data now collected

do not indicate any clear relationship between the percentage content of sugars and acid in the fruit at the time of plucking and the behaviour of the fruit in storage; special attention is now being given to the behaviour of Bramley's Seedling apples from 60 trees on pure-line East Malling stocks when stored at temperatures near 3°C.

Kidd and West have also studied the respiration of pears, stored at 1°C., in air and other mixtures of nitrogen and oxygen, and their results are summarised as follows :—

(1) With traces of oxygen present (1-2 per cent.) the rate of production of carbon dioxide is depressed to approximately half that in air.
(2) Under such conditions pears can maintain a steady state of metabolism for many months at 1°C.
(3) With 5 per cent. of oxygen present the rate of production of carbon dioxide is only slightly depressed, as compared with that in air.
(4) In 100 per cent. oxygen, the rate is practically the same as in air.
(5) The form of the record of respiratory activity for the complete storage life in air and in 100 per cent. oxygen at 1°C. resembles that obtained for apples.
(6) The main effect of a high concentration of oxygen (100 per cent.) is to "telescope" the life cycle.
(7) The balance of carbohydrate metabolism is different in air and in nitrogen; after transferring a pear from air to nitrogen, or *vice versa*, the passage from one balanced state to the other occupies about 40 days.
(8) As in the case of apples, pears with the highest pitch of respiratory activity have the shortest life.

A study of the metabolism of the potato and tomato at low temperatures by J. Barker has yielded interesting results, as small changes in the store temperature not only lead to marked changes in the starch-sugar balance but also to large changes in the rate of respiration. At 34°F. a gradual accumulation of sugar takes place but when such sweet potatoes are transferred to a higher temperature (50°F.) the respiration is much higher than for normal potatoes, the accumulated sugar rapidly disappearing after which the respiration rate becomes normal.

Kidd has carried out a study of the fungal wastage occurring in apples during overseas transport, the observations being continued for some 2 months after the vessels had discharged. *Diaporthe perniciosa* and *Physalospora Cydoniæ* were the most important of the eleven fungi identified.

West summarises the results of the last 8 years' work on the storage of home-grown fruit—mainly Bramley's Seedling apples. The most general relation which has been found to hold is that low nitrogen content of the fruit is accompanied by good keeping quality. The onset of senescence in stored apples is marked by a definite rise in respiratory activity and the phenomenon appears to be associated

less with the gathering, or fall, of the apple than with the development of flavour, aroma and wax on the skin. It is also shown that the storage life of an apple is markedly affected by the temperature, humidity and composition of the air of the store. For each variety of apple tested there was found a critical minimum storage temperature below which the fruit rapidly deteriorated until the browning of the apple flesh, now termed "low temperature internal breakdown", was reached.

An investigation of the vitamin content of English fruit has been undertaken in co-operation with Dr. Zilva of the Lister Institute.

Other interesting sections of the report are those on the Wastage of Fruit in Commerce and the Cold Storage of Vegetables (Barker), Humidity and the Growth of Moulds (Tomkins) and the Control of Temperature and Humidity (Smith). [B. C. B.]

NEW BOOKS

On Agriculture and Allied Subjects

1. Recent Advances in Plant Physiology, by E. C. Barton-Wright. With a Foreword by Professor R. Ruggles Gates, M.A. Pp. 352 ; 51 illus. (London : J. & A. Churchill.) Price, 12*s*. 6*d*.
2. Fungous Diseases of Plants in Agriculture, Horticulture and Forestry, by J. Eriksson. Pp. viii+526 ; illus. (London : Bailliere, Tindall & Cox.) Price, 35*s*.
3. The Crop-Grower's Companion, by John Porter, B.Sc., N.D.A., N.D.D. Pp. xxi+447. (London : Gurney and Jackson.) Price, 8*s*. 6*d*. net.
4. Heredity in Live Stock, by C. Wriedt. With a Foreword, by Prof. R. C. Punnett. (London : Macmillan & Co.)
5. The Organisation of Farming, by G. T. Garratt. (Cambridge : W. Heffer & Sons, Ltd.)

The following publications have been issued by the Imperial Department of Agriculture in India since our last issue :

Memoirs.

1. Some Digestibility Trials on Indian Feeding Stuffs, V. Feeding Trials on American and Indian Cotton Seeds, By. P. E. Lander, M.A., D.Sc., A.I.C., and Pandit Lal Chand Dharmani, L.Ag., B.Sc. (Agri.) (Chemical Series, Vol. X, No. 7.) Price, As. 10 or 1*s*.
2. A Study of Capillary Rise of Water under Field Conditions, by Ashutosh Sen, M.Sc. (Chemical Series, Vol. X, No. 9.) Price, As. 5 or 6*d*.

List of Agricultural Publications in India from 1st August 1929 to 31st January 1930.

No.	Title	Author	Where published
	GENERAL AGRICULTURE		
1	*The Agricultural Journal of India*, Vo. XXIV, Parts V and VI, and Vol. XXV, Part I. Price, Rs. 1-8-0 or 2*s*. per part., Annual subscription, Rs. 6 or 9*s*. 6*d*.	Issued under the authority of the Imperial Council of Agricultural Research.	Government of India Central Publication Branch, Calcutta.
2	*Seasonal Notes* of the Punjab Department of Agriculture (Half-yearly).	Issued by the Department of Agriculture, Punjab.	Government Printing, Lahore.
3	*The Journal of the Mysore Agricultural and Experimental Union* (Quarterly). Annual subscription, Rs. 3.	B. Narasinha Iyengar (Editor).	Bangalore Press, Bangalore.
4	*The Madras Agricultural Journal* (Monthly). Annual subscription, Rs. 4; single copy, As. 6.	B. Viswanath and others (Editors).	The Electric Printing Works, Coimbatore.
5	*Poona Agricultural College Magazine* (Quarterly). Annual subscription, Rs. 2-8; single copy, As. 10.	V. G. Deshpande and S. M. Rao (Editors).	Aryabhushan Press, Poona City.
6	*The Nagpur Agricultural College Magazine* (Quarterly). Annual subscription, Rs. 3.	S. M. Ali and N. B. Chinchalkar (Editors).	Udyam Desha Sevak Press, Nagpur.
7	*The Allahabad Farmer* (Quarterly). Single copy, As. 8. (Per year Rs. 2.)	W. B. Hayes (Editor) .	The Mission Press, Allahabad.
8	*Quarterly Journal of the Indian Tea Association*. Price, As. 6 per copy.	Scientific Department of the Indian Tea Association, Calcutta.	Catholic Orphan Press, Calcutta.
9	*The Planters' Chronicle* (Weekly). As. 8 per copy.	F. E. James (Editor). .	Diocesan Press, Post Box 455, Madras.
10	*Rural India* (Monthly). Single copy, As. 6. Annual subscription, Rs. 3.	A. Swaminatha Aiyer (Editor).	Magazine Press, Chingleput.
11	Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau), for the year 1928-29. Price, Rs. 2-8 or 4*s*. 6*d*.	Issued by the Imperial Institute of Agricultural Research, Pusa.	Government of India Central Publication Branch, Calcutta.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
12	Villagers'Calendar, 1930 (English)	Issued by the Madras Department of Agriculture.	Government Press, Madras.
13	The Improvement of Sugarcane Seed (English and Telegu). Madras Department of Agriculture Leaflet No. 58.	A. C. Edmonds . .	Ditto
14	The Production of Fodder and Green Manure Seeds. (English and Telegu). Madras Department of Agriculture Leaflet No. 59.	Ditto . . .	Ditto.
15	Results of Demonstrations of Agricultural Improvements in the Madras Circle carried out in 1924-27. Madras Department of Agriculture Bulletin No. 97.	Rao Bahadur D. Ananda Rao.	Ditto.
16	Pepper cultivation in the West Coast. (English, Malayalam and Kanarese). Madras Department of Agriculture Bulletin No. 98.	M. Govinda Kidavu and P. A. Venkateswaran.	Ditto.
17	Results of Experiments at Samalkota on Intermediate Season Cropping. Madras Department of Agriculture Bulletin No. 99.	A. C. Edmonds and G. Jogiraju.	Ditto.
18	Annual Report of the Department of Agriculture in the Bombay Presidency for the year 1928-29.	T. F. Main, O.B.E. . .	Government Central Press, Bombay.
19	Artificial Fertilizers. Bengal Department of Agriculture Leaflet No. 4 of 1929.	Issued by the Department of Agriculture, Bengal.	Sreenath Press, Dacca.
20	Cultivation of English Vegetables. Bengal Department of Agriculture Leaflet No. 5 of 1929.	Issued by the Department of Agriculture, Bengal.	Ditto.
21	Tobacco in Bengal. Bengal Department of Agriculture Bulletin No. 6 of 1929.	Ditto . . .	Ditto
22	Improved Ploughs for the use of the Bengal cultivators.	Ditto . . .	Ditto.
23	Report on the Operations of the Department of Agriculture, Punjab, for 1927-28. Part I, Price, Rs. 1-4 ; Part II, Vol. II, Price, Rs. 10.	Issued by the Department of Agriculture, Punjab.	Government Printing, Lahore.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
24	A Note on 289-F American Cotton for Farmers. Punjab Department of Agriculture Leaflet No. 74.	Issued by the Department of Agriculture, Punjab.	Government Printing, Lahore.
25	Some hints for making a lawn. Punjab Department of Agriculture Leaflet No. 75.	Ditto . . .	Ditto.
26	Rules for the control of Well Borers.	Ditto . . .	Ditto.
27	Report on the working of the Department of Agriculture of Central Provinces for the year ending 31st March, 1929.	F. J. Plymen, C.I.E. .	Government Press, C P., Nagpur.
28	Introduction of Long Staple Cotton in the United Provinces, its past, present and future.	B. Ram Prasad . .	Government Press, Allahabad.
29	Report on the Agricultural Stations in the Central Circle, Cawnpore, United Provinces, for the year ending June 30, 1929.	Issued by the Department of Agriculture, United Provinces.	Ditto.
30	Report on the Agricultural Stations of the Western Circle, Aligarh, United Provinces, for the year ending June 30, 1929.	Ditto . . .	Ditto.
31	Combined Report on the Experimental Stations in the Eastern Circle, Partabgarh, United Provinces, for the year ending May 31, 1929.	Ditto . . .	Ditto.
32	Report on the Agricultural Stations of the North-Eastern Circle, Gorakhpur, United Provinces, for the year ending June 30, 1929.	Ditto . . .	Ditto.
33	Report on the Agricultural Stations in the Rohilkhand Circle, Shahjahanpur, United Provinces, for the year ending May 31, 1929.	Ditto . . .	Ditto.
34	Report on the Agricultural Stations in the Bundelkhand Circle, Allahabad, United Provinces, for the year ending June 30, 1929.	Ditto . . .	Ditto.
35	Report on the Agricultural Stations in the Hill Circle, United Provinces, for the year ending June 30, 1929.	Ditto. . . .	Ditto.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*concld.*		
36	Annual Report of the Department of Agriculture, Bihar and Orissa, for 1928-29.	B. C. Burt, M.B.E. . .	Government Printing, Bihar and Orissa, Gulzarbagh.
37	Annual Report on Experimental Farms, Bihar and Orissa, for 1927-28 and 1928-29.	Issued by the Department of Agriculture, Bihar and Orissa.	Ditto.
38	Sugarcane for Orissa Range (in English and Oriya). Bihar and Orissa Department of Agricultural Leaflet.	Ditto . . .	Ditto.
39	Sweet Potato (in Assamese, Bengali and Khasi). Assam Department of Agriculture Leaflet No. 2 of 1929.	Issued by the Department of Agriculture, Assam.	Government Press, Shillong.
40	Instructions for Testing Agricultural Seeds. Burma Cultivator's Leaflet No 62.	Issued by the Department of Agriculture, Burma.	Government Press, Rangoon.
	AGRICULTURAL STATISTICS		
41	Agricultural Statistics of India, 1927-28. Vol II. Price, Rs. 1-4-0 or 2*s*. 3*d*.	Issued by the Department of Commercial Intelligence and Statistics, India.	Government of India Central Publication Branch, Calcutta.
42	Season and Crop Report of the Punjab for 1928-29.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
43	Tables of Agricultural Statistics of the Punjab for 1928-29.	Ditto. . . .	Ditto.
	FRUIT CULTURE		
44	A List of Fruit Nurseries in the Punjab recommended for the purchase of Plants. Punjab Department of Agriculture Leaflet No. 73.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
45	Banana Culture (in Assamese and Bengali). Assam Department of Agriculture Leaflet No. 1 of 1929.	Issued by the Department of Agriculture, Assam.	Government Press, Shillong.
46	Papaya Culture (in Assamese and Bengali). Assam Department of Agriculture Bulletin No. 1 of 1929.	Ditto . . .	Ditto.

No.	Title	Author	Where published
	AGRICULTURAL CHEMISTRY		
47	The Applications of the Antimony Electrode to the Determination of the pH value and the Lime Requirement of Soils. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 4. Price, As. 5 or 6*d*.	W. H. Harrison and P. N. Vridhachalam.	Government of India Central Publication Branch, Calcutta.
48	Some Digestibility Trials on Indian Feeding Stuffs, IV: Some Punjab Hays. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 5. Price, As. 7 or 9*d*.	P. E. Lander and Pandit Lal Chand Dharmani.	Ditto.
49	Some Digestibility Trials on Indian Feeding Stuffs, V: American and Indian cotton seeds. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 6.	Ditto . . .	Ditto.
50	A New Method of Dispersing Soils for Mechanical Analysis. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 8.	Amar Nath Puri . .	Ditto.
51	Soils of the Bombay Presidency. Bombay Department of Agriculture Bulletin No. 160 of 1929. Price, As. 7.	Rao Bahadur D. L. Sahasrabuddhe.	Government Central Press, Bombay.
	BOTANY		
52	The Calculation of Linkage Values. A Comparison of various Methods. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 1. Price, Re. 1 or 1*s*. 6*d*.	Mahbub Alam. . .	Government of India Central Publication Branch, Calcutta.
53	Studies in Indian Oil Seeds, No. 3, *Carthamus tinctorius* Linn. The Types of Safflower. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 3. Price, As. 4 or 5*d*.	Khan Sahib Abdur Rahman Khan.	Ditto.
	MYCOLOGY		
54	Cotton Wilt. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVII, No. 3. Price, Re. 1-4 or 2*s*. 3*d*.	Jehangir Fardunji Dastur.	Government of India Central Publication Branch, Calcutta.

No.	Title	Author	Where published
	ENTOMOLOGY		
55	List of Publications on Indian Entomology, 1928. Pusa Bulletin No. 200. Price, As. 7 or 9*d*.	Compiled by the Imperial Entomologist, Pusa.	Government of India Central Publication Branch, Calcutta.
56	Insects and general control of Insect Pests. Bengal Department of Agriculture Bulletin No. 3 of 1929.	Issued by the Department of Agriculture, Bengal.	Sreenath Press, Dacca.
	ANIMAL HUSBANDRY AND DAIRYING		
57	*The Journal of the Central Bureau for Animal Husbandry and Dairying in India*, Vol. III, Parts III and IV. Price, As. 10 per part. **Annual subscription Rs. 2-8.**	Issued under the authority of the Imperial Council of Agricultural Research.	Government of India Central Publication Branch, Calcutta.
58	Summary of the Conclusions and Recommendations of the Royal Commission on Agriculture in India with regard to Cattle (Assamese and Bengali). Assam Department of Agriculture Leaflet No. 3 of 1929.	Issued by the Department of Agriculture, Assam.	Government Press, Shillong.
59	List of Horse and Cattle Fairs and Shows in the Punjab and Punjab States during 1929-30.	Issued by the Director of Veterinary Services, Punjab, Lahore.	Government Printing, Lahore.
	VETERINARY		
60	Report of the Imperial Institute of Veterinary Research, Muktesar, for the year ending 31st March, 1929.	Hugh Cooper . . .	Government of India Central Publication Branch, Calcutta.
61	Scientific Papers of the Civil Veterinary Department, Madras, Vol. I.	Issued by the Director of Veterinary Services, Madras.	Government Press, Madras.

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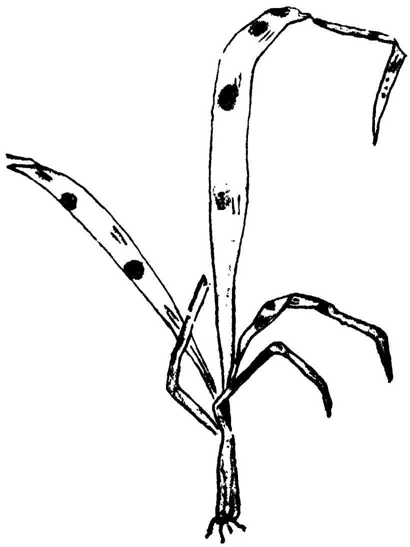

A wheat plant infected with " powdery mildew. " The black dots show the perithecia.

ORIGINAL ARTICLES

STUDIES ON THE ANNUAL RECURRENCE OF "POWDERY MILDEWS" OF WHEAT AND BARLEY IN INDIA, I.*

BY

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The "powdery mildews" caused by *Erysiphe graminis* D. C. have long been known as serious pests of wheat, barley, oats, etc., in Europe and North America. Butler[1] has recorded mildew on wheat alone from amongst the cereals in this country. The writer has frequently observed it on barley also.

As far as the plains of India are concerned, this disease is of very little importance because it is rarely found on cereal crops.

During his investigations on the "rusts of cereals" in the Kumaon hills and in the neighbourhood of Simla, the writer noticed very serious attacks of "powdery mildew" on wheat and barley crops. The disease is very common also at the foot of the hills.

Judging from the severity of the infection year after year it was thought desirable to study the incidence of this disease more minutely. This note is only an attempt to state the present position of the work in hand.

Erysiphe graminis is a well-known obligate parasite which produces irregular patches of a web-like coating on the leaves and other parts of its host. (Pl. XVII.) In the hills it has been frequently found on the ears as well.

The mycelium is superficial with haustoria only in the epidermal cells. The colour of the mycelium soon changes from white to grey and the patches present a powdery appearance on account of the formation of conidia.

Perithecia are formed on the same mycelium at the time when the crop is in ears and they appear to the naked eye as small black dots, when ripe.

It is well known that the "powdery mildews" are propagated in summer (in cold countries) by the conidia, which, being disseminated by wind and other agencies spread infection on the crop.

** Paper read at the 17th meeting of the Indian Science Congress, Allahabad, January 1930.

[1] Butler, E. J. *Fungi and disease in plants.* Thacker Spink and Co., Calcutta, 1918.

As stated by Salmon,[1] the perithecia carry the fungus over winter, and the ascospores liberated from the perithecia produce the first infection of the season in the following spring.

That is briefly the life-history of the parasite in countries with a severe winter.

Perithecia may, under certain conditions, produce infection in the same season in which they are produced, as mentioned by Dame Gwynne-Vaughan.[2]

Brooks[3] has stated that under English conditions the conidial stage of the fungus may be found on cereals and grasses in sheltered situations throughout winter.

It is not difficult to explain the fresh outbreaks of this disease in such countries where the parasite may live on self-sown host plants during the critical period.

Erysiphe graminis being an ecto-parasite flourishes under moist conditions or at sheltered situations.

For the last four years *Erysiphe* has been grown successfully from January to April on wheat and barley in a sheltered cage attached to our Botanic Garden at Agra. In the year 1927 a culture of *Erysiphe* was started in October with conidial material brought down from Muktesar. After the middle of April all inoculations have given negative results. The conidia lose their viability under high temperatures.

Erysiphe on wheat was observed only once in an epidemic form at Allahabad (on the plains) in a low-lying field in the neighbourhood of big pools of water.

It was first observed on February 16th, 1929, when there was hardly a plant free from it. By the third week of March, when the weather was rather warm and dry, most of it had disappeared.

Failure to grow *Erysiphe* in the beginning of summer on the plains, even under protection, indicates a complete loss of viability of the conidia due to heat.

The writer[4] has recorded a similar experience with rusts as far as the uredo-stage is concerned.

On account of the absence of self-sown plants and consequently of *Erysiphe*, even at the foot of the hills between harvest (March-April) and the sowing of the crop (October-November), it seems impossible for the conidial stage of this fungus to survive the summer heat at those places.

The perithecial material collected at the harvest time from fields in the hills and at the foot of the hills has invariably been found to be sterile (without ascospores).

Further the absence of *Erysiphe* on the crops at the foot of the hills normally for two months or so, after the sowing, suggests that the perithecia left in the soil are of little use for fresh infection of crops at those localities.

It is interesting to note that, like some of the cereal rusts, this fungus too lives on self-sown plants and tillers of wheat and barley in the hills during summer.

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[1] Salmon, E. S. A monograph of the Erysiphaceæ. *Memoirs of the Torrey Botanical Club*, Vol. IX, 1900.

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It seems probable therefore that the wheat and barley crops in the hills get infected by the conidia found in plenty on self-sown plants at the time when the crops are sown.

The most evident factor of annual recurrence of " powdery mildews " seems to be the survival of the conidial stage up in the hills.

Regular incidence of these pests on crops at the foot of the hills and their casual appearance on crops in the plains under moist conditions of weather and soil is probably due to wind-blown infection from the hills.

Following a successful infection of the hill crops in October-November, the fungus grows rather slowly on account of the winter cold and after a comparatively long incubation appears in the conidial stage by December-January.

How far the perithecia in the hills, from the previous crop, are responsible for fresh infection every season, it is not possible to say definitely at this stage.

It is not unlikely that, on account of frequent showers of rain in the hills, most of the perithecia may bring about infection the same season in which they are produced, as has been stated above.

Up in the hills on account of a severe winter and snow, the perithecia from the previous crop could not be expected to germinate before March-April.

At any rate the appearance of mildews on the hill crops as early as December and January clearly indicates that the survival of conidia from the previous crop is a factor of outstanding importance.

The life-histories of these parasites are under investigation at the laboratories at Simla and Almora, along with investigations on cereal rusts under the auspices of the Imperial Council of Agricultural Research.

In view of the serious damage which the parasites under report do to the wheat and barley crops in the hills and at the foot of the hills, it is necessary that a study of the biologic forms of *Erysiphe graminis* D. C. and that of the physiologic forms of the two races (*tritici* and *hordei* Marchal) be made in this country, on the lines of work done by Salmon[1] and Mains and Dietz.[2]

Information on those lines will be of immense use in the selection and breeding of resistant varieties, for cultivation in the hills and such places on the plains which are cool and damp.

I wish to express my warmest thanks to Mr. Babu Lal Gupta, one of my colleagues, for his assistance in this work.

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STUDIES IN THE POLLINATION AND SEED FORMATION OF WATER-HYACINTH (*EICHHORNIA SPECIOSA* KUNTH).*

BY

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Eichhornia speciosa Kunth or water-hyacinth is now a very serious pest in all countries where it has become naturalised.

It has a phenomenal capacity to spread over vast areas within a very short space of time purely by vegetative means. It is further characterized by trimorphic flowers of which the mesostylic form is the most common type. The production of ripe fruits and seeds is generally believed to be rare which has led to this factor being left out of account in all proposals for its eradication.

It is not surprising, therefore, that a review of the literature on the subject shows that definite information regarding the occurrence of fruits and seeds in nature as well as the conditions under which this takes place is not available.

Fritz Müller[7]† was the first to draw attention to the production of ripe fruits and seeds in *Eichhornia speciosa*. For a long time he searched in vain for these and inferred that the absence of fruits containing seeds was due to only one form of the plant (the mesostylic) being present at Blumenau. Later he found by experiment that pollination could successfully be effected with pollen from the same plant and attributed the rarity of fruit formation at Blumenau to the absence from the locality of the insects which acted as pollinating agents.

Müller was, however, only partly successful in reaching the goal of his pollination experiments, which was to determine the extent to which the different modes of pollination—with pollen from the two kinds of stamens of the same as well as other flowers—determined seed production.

The only authors who have since attempted experiments to produce seeds by artificial pollination so far as is known to us are Messrs. Brühl and Sen,[2] whose conclusions are as follows :—"It is not impossible that now and then ripe fruits and seeds of the water-hyacinth may be produced in Bengal under natural conditions. That this does not occur more frequently may be due to the absence of certain insects which may be necessary to produce cross-pollination. If here and there ripe seeds should be produced, their distribution by aquatic birds would explain its appearance in isolated ponds and ditches and thereby the problem of eradication of the water-hyacinth would become even more complicated."

* Paper read at the 17th meeting of the Indian Science Congress, Allahabad, January 1930.
† Reference by superior figures is to the Bibliography on pp. 295-296.

Smith[11] working in Chicago concludes from his investigations that "since *Eichhornia* does not set seed in our latitude and there are apparently no abnormal structures in the embryosac, it is probable that the division of the tube-nucleus is due to the pathological condition of the pollen grains and the failure to produce seed should be ascribed to the same cause."

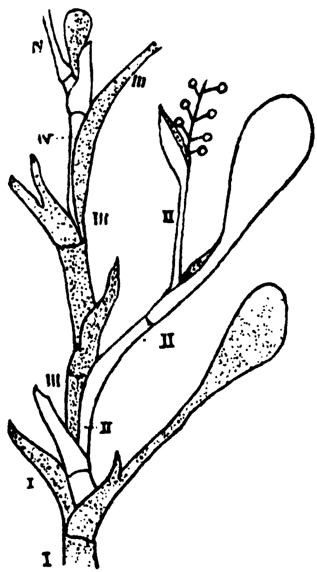
Examination of a large number of plants from different localities in the neighbourhood of Calcutta showed that seed formation under natural conditions was almost completely absent. A re-investigation of the problem appeared, therefore, to be necessary in order to determine the factor or factors involved in the production of seeds in *Eichhornia*.

This was undertaken by us during the year 1929 and the following is a record of the results obtained.

The Biology of the Flower.

Eichhornia speciosa Kunth appears to have two main flowering periods in Calcutta and its neighbourhood. The first period, which is comparatively short, commences from the beginning of April and lasts till the middle of May. The second "flush" is noted towards the end of July and lasts till the middle of December. Isolated inflorescences are also found in various places at other times but the conditions under which these are produced are not accurately known.

The structure of the shoot is sympodial as was pointed out by Warming[13]. Text-figure 1 illustrates the structure of the shoot very clearly.

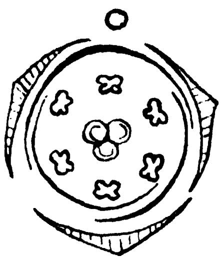


Text-fig. I (after Warming).
The roman numerals indicate successive parts of the sympodial shoot.

The inflorescence is really terminal but is pushed aside by a daughter shoot produced in the axil of one of its leaves. The flowering shoot remains attached to the axillary shoot upto the insertion of its prophyll. The axillary shoot also terminates in an inflorescence and another axillary shoot is produced from the axil of one of its leaves. This process is repeated up to the exhaustion of the plant (cf. Lotsy, J. P.[6]).

The inflorescence is a spike derived from a panicle with shortened branches (cf. Solms-Laubach)[12]. It bears eight to fourteen flowers. The flowers are mesostylous and open as a rule in acropetal succession, but deviation from this condition is not quite uncommon.

The flowers are medianly zygomorphic. The perianth is completely corolline and its parts are arranged in two trimerous whorls, the unpaired member of the outer whorl of which is placed ventrally. The perianth leaves are elongated, blunt and united with one another in their lower halves to form a cylindrical tube. The median dorsal member of the inner whorl is larger than the others and is characterised by a large conspicuous elongated yellow spot surrounded by a dark blue zone which attracts insects. Text-figure 2 illustrates the arrangement of parts of the flower very clearly.



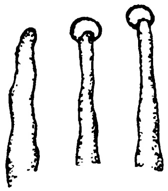
TEXT-FIG. 2. Floral diagram (after Warming).

In a young bud (Plate XVIII, figs. 1 and 2) the style is longer than the six young stamens surrounding it. They are inserted at different levels on the perianth tube and are arranged in two whorls, the three outer having shorter filaments than the three inner. Prior to the opening of the flower the filaments of the three inner stamens increase very much in length and can be seen protruding from the half opened buds. In fully opened flowers (Plate XVIII, fig. 3) they stand at a higher level than the stigma which seems to have grown very little. The filaments of the three outer stamens do not grow very much and stand at the mouth of the corolla tube. The flowers open as a rule early in the morning soon after sunrise. On cloudy and humid days, however, they open later. The anthers burst an hour or two after anthesis according to the temperature of the day. The pollen grains are at first sticky and agglutinated but they soon dry up and form a powdery mass.

1.

2.

3.



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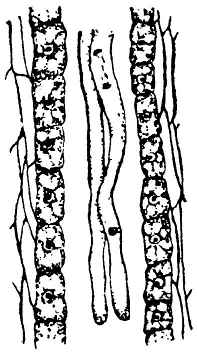

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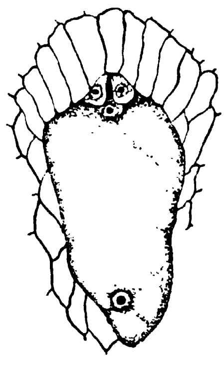

7.

8.

The terminal lobes of the trifid stigmas are covered with unicellular hairs most of which have glandular swellings at the tip (Plate XVIII, fig. 4). Artificial pollination with fresh pollen has shown that the stigma is receptive at the time of anthesis. The relative position of anthers and stigma in open flowers is shown in Plate XVIII, fig. 3.

The mature pollen grains are ellipsoid in outline (Plate XVIII, fig. 5). They absorb water very rapidly and become ovoid. Observations of the pollen grains on artificially pollinated stigmas at frequent intervals show that before germination they absorb moisture from the stigmatic surface and become ovoid. Those which do not absorb moisture fail to germinate. Artificial germination of pollen grains was obtained in distilled water and in 2 per cent. cane sugar solution. Distilled water, however, gave better results. Dry pollen also germinated under moist chamber conditions which shows that the supply of moisture is the most important factor in the germination of *Eichhornia* pollen as in the case of wheat, barley and other plants. The pollen tubes are more or less straight and appear to be quite normal. In no case was a coiled tube as figured by Brühl and Sen obtained.

The style is traversed by three longitudinal canals. The pollen tube, as has been noted by Smith before, traverses the style through these canals. In Fig. 6 on Plate XVIII a pollen tube is seen traversing the style with the generative nucleus in the late metaphase stage. It should be noted that the pollen tube is quite normal and shows no signs of disintegration as was stated to be the case by Smith.

The ovary contains numerous very small ovules. Cytological examination of ovules of fresh flowers showed that the embryo-sac is well developed at the time of anthesis and agrees in detail to the description given by Smith. The synergids are comparatively large and have prominent vacuoles. The egg is relatively small and is situated centrally between the synergids. The antipodals are absent. The polar nucleii have fused and are situated towards the lower end of the embryo-sac away from the egg.

We may perhaps mention here the post-floral curvature of the axis of the inflorescence in *Eichhornia* which has been noted previously by Göebel[5], Schenck[9] and others. Göebel attributes it to "the stalk of the inflorescence lengthening considerably after anthesis and then turning sharply downwards to form a knee-shaped bend". When the plants are growing in shallow water the inflorescence is thus buried in mud. Our observations show that the post-floral increase in length of the stalk of the inflorescence is not very considerable and is confined to an area of about one to two centimeters below the terminal node. It is in this region that the curvature takes place. The degree of curvature attained by the stalk at different times of the day is depicted diagrammatically in Plate XVIII, fig. 8. Removal of the flowers, or amputation of the stalk above the node, has no effect and the curvature is normal. The scapes removed and kept in water also show the usual curvature.

Natural Pollination.

In order to determine to what extent natural pollination occurs in *Eichhornia*, the stigmas of about three hundred fresh flowers growing under natural conditions were examined microscopically ten hours after anthesis. Presence of pollen grains was detected in 15 per cent. of the flowers and another 20 per cent. showed actively growing pollen tubes. This shows that under natural conditions about 35 per cent. of the flowers are pollinated.

The fact that natural pollination in *Eichhornia* does take place under the conditions prevailing in Bengal having been established, the next point of enquiry was regarding the agency by which this was effected. Of the three principal agencies for this purpose water was altogether ruled out of consideration owing to the flowers being situated much above the surface of the water at the time of anthesis. Bagging a large number of inflorescences before anthesis and subsequent microscopic examination of their stigmas after an interval of 8 hours showed the presence of pollen grains in about 20 per cent. of the flowers. Other bagged flowers which were subjected to violent periodical shaking in order to imitate the action of the wind showed 35 per cent. of the flowers pollinated. This shows that wind is responsible for pollination to a certain extent. On the other hand, the general orientation of the floral parts. the stickiness of the pollen and stigmas, the colour of the flower and the attractive spot on one of the petals indicate that insects are probably the most important agents for pollination. Careful search for insect visitors during different parts of the day showed that a bee was the only insect which regularly visited the flowers in the morning, but took no part in pollination. It was obviously attracted by the bright spot on the petal, alighted at its base and inserted its proboscis in the corolla tube in search of nectar. There being no honey it soon withdrew and moved away to another flower, repeating the same operation. In other cases it was noticed that the bee devoured the pollen from the three lowermost anthers and in this operation the baskets on its legs became filled with pollen. In no case was a bee found alighting or brushing past a stigma or dislodging pollen from the uppermost anthers so as to bring about pollination.

Artificial Pollination.

Brühl and Sen[2] obtained viable seeds of water-hyacinth by artificial pollination. They obtained good results when the pollination was made between seven and eight o'clock in the morning. Our investigations confirm this, which appears to be due to the viability of the pollen being greatest and the stigma most receptive just after anthesis.

Our first experiments on artificial pollination were made in the months of April, and May between seven and eight o'clock in the morning on plants growing in the

jhil in the compound of the laboratory. The experiments made and the results obtained are represented in the following table :—

TABLE I.

Artificial pollination experiments during April and May, 1929, on plants growing in the jhil.

No. of inflorescences used	Total No. of flowers	Time of pollination A.M.	Source of pollen	Position of inflorescence after curvature of stalk	Setting percentage
6	68	7—9	Lower (shorter) anthers of the same flower.	Above water .	*Nil*
6	71	Do.	Upper (longer) anthers of the same flower.	Do.	*Nil*
6	63	Do.	Upper (longer) anthers from different plants.	Do.	*Nil*
6	59	Do.	Lower (shorter) anthers from different plants.	Do.	*Nil*

Examination of the above data brings out the fact that not a single fruit was obtained though 261 flowers were pollinated at a time of the day when the stigma was most receptive and the pollen most viable. Self or cross pollination does not seem to have made any difference. The flowers withered and the axis of the inflorescence above the terminal node became flaccid and dried up in the course of a few days.

As the curvature of the inflorescence invariably brought the flowers under water wherever suitable conditions prevailed, it was thought that probably the post-floral development of the ovule took place under water. In order to test the above hypothesis experiments were carried out as follows :—Eight big earthenware receptacles (*gamlas*) were filled with tank water and two to three healthy young plants which were actively growing in the *jhil* were transferred to each. These plants were allowed a week to settle in their new environment before any experiments were started. Some of the flowers were pollinated artificially with pollen from the same plant, while others were pollinated with pollen from different plants. The source of pollen, the date and time of pollination were noted on a label attached to the stalk. In most cases a free water surface being available the inflorescence went under water. But in some cases where the inflorescence was situated at the side of the *gamla*, the post-floral curvature of the scape did not bring the flowers under

water owing to the intervention of the rim. These served as controls. The experimental results are represented in the accompanying table :—

TABLE II.

Artificial pollination during April and May on plants growing in the gamlas.

No. of inflorescences	Total No. of flowers	Time of pollination A.M.	Source of pollen	Position of the flower after curvature of axis of inflorescence	Percentage of fruits formed
6	53	7—9	i. Upper anthers of same flower.	Under water .	71·3
6	59	Do.	ii. Lower anthers of same flower.	Do.	55·9
6	61	Do.	iii. Upper anthers of different flowers.	Do.	52·4
3	28	Do.	iv. Lower anthers of different flowers.	Do.	25·0
6	67	Do.	(i), (iii) and (iv) .	Above water .	*Nil*
3	32	Do.	(ii), (iii) and (iv) . .	Do.	*Nil*

Examination of the above data shows that fruits can be formed in water-hyacinth when the inflorescence is submerged under water after pollination. The flowering ceased towards the middle of May and the work could not be continued. Experiments in the month of July when flowers were again available, however, gave very interesting results. It was noted that seed formation could take place both above and under water, the time of pollination and the source of pollen being the same as in the previous experiments. Setting was obtained in ten inflorescences which were growing outside the *gamla*. The period of development was the same as in the case of those fruits which developed under water. The seeds show no morphological difference and have been found to be quite viable.

Almost the only cause to which these results could be ascribed is the difference in the relative humidity of the air in the months of April-May and July. The Alipore Observatory figures for these months are given below. For purposes of convenience the data have been averaged for 3 day periods.

TABLE III.

Comparative records of maximum and minimum temperatures and relative humidity during the months of April, May and July when artificial pollinations were made.

Date	Maximum Temp. ° F. (average of three days)	Minimum Temp.° F. (average of three days)	Relative humidity %	Date	Maximum Temp. ° F.	Minimum Temp. ° F.	Relative humidity %
April.				*July.*			
15th, 16th, 17th .	96·4	74·0	82·0	1st, 2nd, 3rd . .	95·4	80·0	91·6
18th, 19th, 20th .	95·6	71·9	79·3	4th, 5th, 6th . .	90·0	80·4	93·3
21st, 22nd, 23rd .	95·1	73·5	89·6	7th 8th, 9th . .	89·3	80·0	93·6
24th, 25th, 26th .	94·7	79·0	74·3	10th, 11th, 12th .	88·6	79·3	92·6
27th, 28th, 29th .	97·8	82·3	86·6	13th, 14th, 15th .	87·9	78·6	91·3
April and May.							
30th, 1st, 2nd . .	97·1	82·9	81·6	16th, 17th, 18th .	87·7	78·1	91·3
3rd, 4th, 5th . .	95·1	81·5	83·3	19th, 20th, 21st .	85·4	78·4	91·0
6th, 7th, 8th . .	96·4	84·2	81·0	22nd, 23rd, 24th .	85·4	71·1	95·0
9th, 10th, 11th . .	93·9	80·4	75·6	25th, 26th, 27th .	87·4	78·9	93·3
12th, 13th, 14th .	97·0	79·8	85·3	28th, 29th, 30th .	83·4	77·2	95·6

A difference in the intensity of light due to the amount of cloud (3·3 tenths in April, 4/10 in May and 8·5 tenths in July and August) during these months is possibly a contributory cause. This point, however, was not specially studied during the course of the experiments.

The fruits generally take twenty to twenty-three days to mature. They are enclosed within the persistent lower part of the perianth. After maturation they are severed from the axis by an abscisson layer and float freely on the surface of the water for a day or two before sinking. Splits develop on the lateral walls from which seeds are discharged. The seeds are very small, brown in colour, and agree in morphological details with those described by other investigators. The seeds germinate freely in tap water and distilled water.

DISCUSSION.

It is a well-known fact that there is a tendency in plants which propagate vegeta tively to lose their capacity for sexual reproduction. Sterility in these cases is generally associated with the abnormal development of the male or the female gametophyte. Cytological examination of *Eichhornia* shows that the embryo-sac is well developed at the time of anthesis, as also are the pollen grains prior to their liberation from the micro-sporangium. Germination of pollen *in vivo* and *in vitro* gave the expected results. Examination of plants growing in their natural habita-

showed that although a certain proportion of the flowers had been pollinated no seed formation took place. Experiments in artificial pollination on plants growing in the *jhil* in April and May gave negative results. This led us to believe that there were other factors besides pollination which interfered with the normal development of the seed.

Our experiments in artificial pollination in summer showed good setting only when the post-floral development took place under water. During the monsoons, however, setting took place above water as well. An examination of the climatological data of these periods supplied by Mr. V. V. Sohoni, then Meteorologist of the Alipore Observatory, shows that in summer a comparatively high temperature and relative humidity lower than 90 per cent. prevailed, whereas during the monsoons the temperature was only slightly lower, but the humidity was above 90 per cent. all along. We infer from this that setting of fruit can only take place in *Eichhornia* either (i) when the fruit can develop under water or (ii) when the relative humidity of the air is higher than 90 per cent. so that an immersion in water of the pollinated flowers becomes unnecessary. As such conditions are of frequent occurrence in Bengal, *we infer that seed formation must be taking place on a fairly large scale in Bengal which makes the problem of the eradication of the water-hyacinth far more complicated than before.*

In this connection we may be permitted to refer to the interesting discovery of seedlings of water-hyacinth, made by Prof. Parija of the Ravenshaw College, Cuttack, in June 1929 in a tank at Barada about 15 miles from Cuttack. One of us had the good fortune of visiting the locality with Prof. Parija and he was able to bring nearly a thousand seedlings to Calcutta from that locality. The seedlings developed quite normally in the *jhil* attached to our laboratory. As Professor Parija is going to describe the seedlings and their biology elsewhere we do not wish to say anything on that subject.

Summary.

1. The flowers open as a rule in the morning soon after sunrise ; on cloudy and humid days, however, they open later.

2. The stigma stands high above the stamens in the bud stage. After the opening of the flowers, the stigma occupies a position lower than that of the three upper anthers. The three lower anthers are situated at the mouth of the corolla tube. The flowers are mesostylous.

3. Dry pollen grains are ellipsoid in outline. They imbibe water very rapidly and become ovoid. Germination on the stigma takes place within an hour after pollination.

4. The style is traversed by three longitudinal canals. The pollen tubes traverse the style through these canals.

5. From the structure of the flower and the relative positions of the stamens and stigma, the flower appears to be insect-pollinated. A bee has been observed to visit

the flowers regularly in the morning; it does not appear, however, to take any part in their pollination.

6. Under natural conditions 35 per cent. of the flowers are pollinated. Bagging experiments show that self-pollination to a considerable extent occurs in this plant.

7. The axis of the inflorescence bends downwards considerably after flowering and brings the flowers under water wherever a free water surface is available. Removal of the flowers or amputation of the inflorescence above the uppermost node has no effect on this bending.

8. Seed formation under natural conditions has not as yet been reported from Bengal. The conditions necessary for the formation of the seed are not as yet fully understood. Humidity of the atmosphere and temperature appear to have great influence. By artificial pollination seeds have been obtained from flowers of inflorescences not submerged in water during the rainy season. At other times seed formation only took place in inflorescences which were under water.

Our thanks are due to Mr. P. K. Bose, assistant in the Botanical Laboratory, for having assisted us in connection with some of the pollination experiments and observations.

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SOWING DATE EXPERIMENTS WITH PUNJAB-AMERICAN COTTONS AT LYALLPUR, 1926-29.

BY

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A SOWING date experiment was carried out at Lyallpur in each of the four years 1926-29. Owing to the limited area available, it was decided that daily flowering and daily bolling records should be taken during the growing period from selected average plants and that the total yields from beds should not be recorded. In this way it was expected more reliable results would be obtained than by using the bed yields owing to the small size of the beds. In each year also daily increase in height records were taken in certain sowings. The single plants on which records were taken were selected at an early stage in their growth for uniform spacing from other plants and for uniform growth — as judged by eye — when compared with other selected plants, the growth being the average of the plants in the plot (cf. the work of Balls (1917), Thomas & Sawhney (1925), Bailey & Trought (1926)). Beds of individual sowing dates were replicated and arranged as recommended by Engledow and Yule (1926).

In 1926, 1928 and 1929, there were ten repetitions, and in the 1927 sowing, eight repetitions of each bed.

1926 EXPERIMENT.

The variety of cotton used was 285F. The plot was ridged, the ridges being 2′ 3″ apart. For the first sowing, seed was dibbled by hand, and 5 or 6 seeds, at 15″ distance, two-thirds of the way down the ridge on its southern aspect, were put in each hole. The seed was sown dry, and the beds irrigated immediately after. As with 5 or 6 seeds per hole germination was not satisfactory, in the second and subsequent sowings about 20 seeds per hole were sown and germination was on the whole quite satisfactory. Each bed consisted of 5 ridges, and six holes from the middle ridge of each bed were selected for records.

The dates on which sowings were made were :—

1st sowing	March 15th
2nd "	" 31st
3rd "	April 15th
4th "	" 30th
5th "	May 15th

In each bed plants were thinned out to two plants per hole.

Resowing took place where necessary and a plan of the plot was drawn up showing the resown holes (as also in subsequent years). These holes were also marked in the field. The germination of the first sowing on March 15th was not satisfactory – the average of all the beds twelve days after sowing was just under 45 per cent. In the third sowing the seed was soaked in water for 12 hours before sowing. The table below shows the date of commencement of germination for each sowing.

Sowing	1st	2nd	3rd	4th	5th
Date of sowing . . .	15-3-26	31-3-26	15-4-26	30-4-26	15-5-26
Start of germination. (Appearance above ground.)	21-3-26	5-4-26	19-4-26	3-5-26	18-5-26
No. of days from sowing .	6	5	4	3	3
Dates of early irrigations .	15-3-26	..	..	..	..
	31-3-26	31-3-26	..	..	..
	15-4-26	15-4-26	15-4-26	30-4-26	..
	..	30-4-26	15-5-26	15-5-26	..

The dates of irrigation were determined arbitrarily, bearing in mind Balls and Holton's (1915) suggestion that early sown seedlings suffer from water strain more than later sown seedlings. By giving two early waterings to the earliest sown at intervals of a fortnight and one watering to each of the other sowings a fortnight after the sowing irrigation, it was hoped to reduce or eliminate this early water strain.

The daily increases in height curves were taken from the 1st, 3rd and 5th sowings. (Diag. I.)

At the time of commencing height measurements the plants were 43, 30 and 22 days old respectively. It will be noticed that the actual amount of daily growth was approximately the same for each sowing, though it is clear from the curve that the 5th sowing was increasing its rate of daily growth more rapidly. The average height from the cotyledon node to the growing point for each of the sowings was 5·85 cm., 6·74 cm. and 5·22 cm. respectively.

The growth curves show that the daily increase of the 5th sowing after the 25th of June was, almost without exception, greater than in either of two earlier sowings, and that the 3rd sowing maintained in general a higher daily average than the first sowing after about the 20th of June. The actual final heights however on the 25th of August when height measurements ceased were 84·4 cm., 79·1 cm. and 77·3 cm. respectively for the three sowings, showing that in spite of the greater increase per plant per day the later sowings never quite caught up the earlier sowings. It will

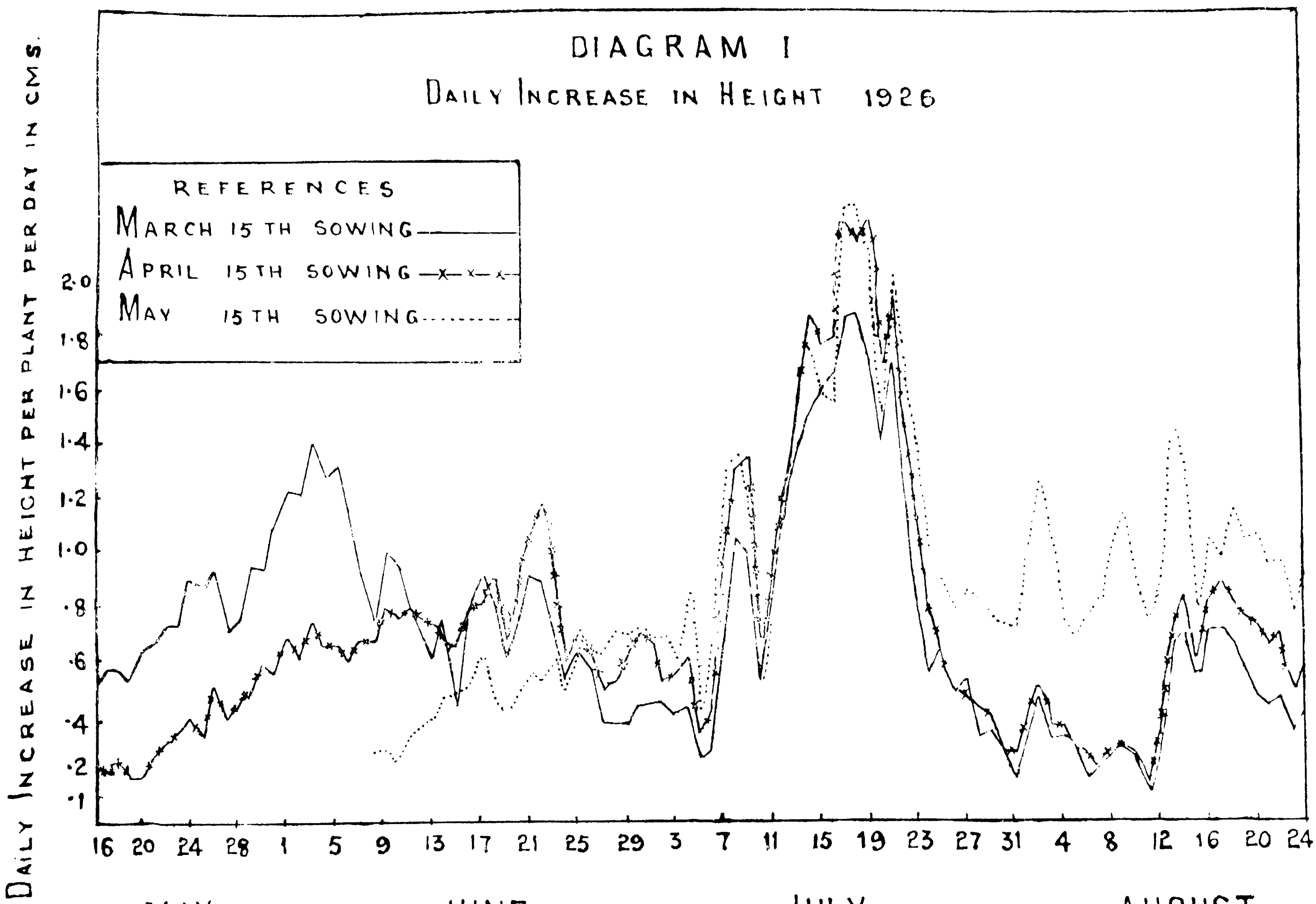
DIAGRAM I
DAILY INCREASE IN HEIGHT 1926
REFERENCES
MARCH 15TH SOWING
APRIL 15TH SOWING
MAY 15TH SOWING
DAILY INCREASE IN HEIGHT PER PLANT PER DAY IN CMS.
2·0
1·8
1·6
1·4
1·2
1·0
·8
·6
·4
·2
·1
16 20 24 28 1 5 9 13 17 21 25 29 3 7 11 15 19 23 27 31 4 8 12 16 20 24
MAY
JUNE
JULY
AUGUST

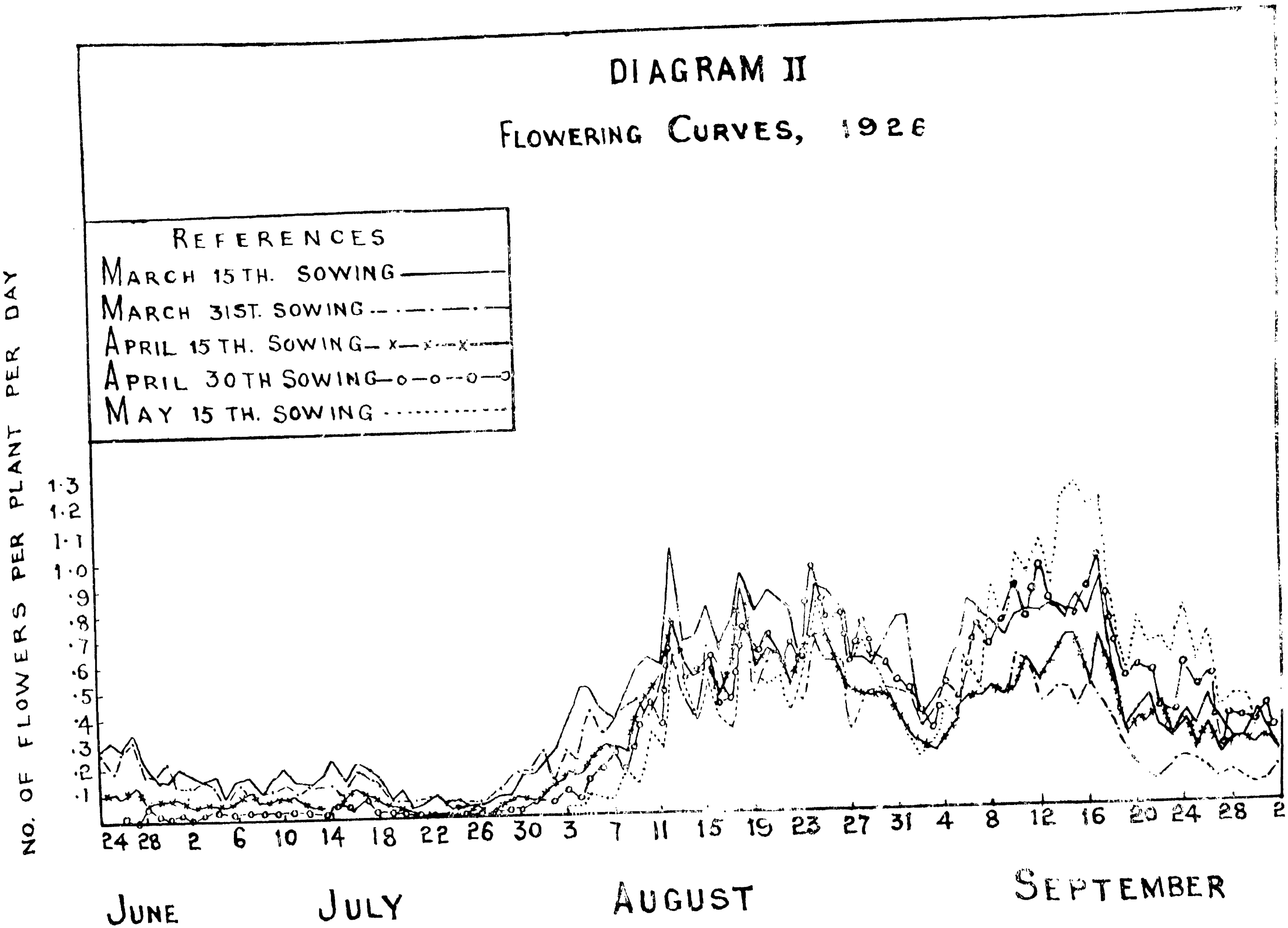
DIAGRAM II
FLOWERING CURVES, 1926
REFERENCES
MARCH 15TH. SOWING
MARCH 31ST. SOWING
APRIL 15TH. SOWING
APRIL 30TH SOWING
MAY 15TH. SOWING
NO. OF FLOWERS PER PLANT PER DAY
1·3
1·2
1·1
1·0
·9
·8
·7
·6
·5
·4
·3
·2
·1
24 28 2 6 10 14 18 22 26 30 3 7 11 15 19 23 27 31 4 8 12 16 20 24 28 2
JUNE
JULY
AUGUST
SEPTEMBER

be noted that in general there are very considerable similarities in the daily fluctuations of the three curves. The environmental conditions, however, have not succeeded in disguising the sowing date effect, though the first and the third sowings show very considerable parallelism in their early stages. In the beginning of June the daily increases per day in the first sowings reached just over 1 cm., but instead of continuing to increase (as in Egypt) the daily rate at Lyallpur decreased and continued to decrease until the commencement of the rains. The third sowing also shows, during this period, the effect of the environment, whereas in the fifth sowing, the effect is not so marked and the plant appears to advance steadily, though the rate of progress may have been somewhat decreased. If an early depressant factor were operating in the earlier sowings more severely than in the 5th sowing, and this depressant factor resulted in decreased total root growth, then, at a later period of severe environmental conditions the earlier sowings would be more susceptible and would show a greater reaction to the unfavourable conditions, as the roots' absorptive capability would be proportionately lessened. An examination of the maximum temperatures during June shows that they were extremely high at the beginning and at the end of June with a break just after the middle of the month which corresponds with the definite increase in the daily growth rate in the first and third sowings. The curves show in fact that, while the first and third sowings do decrease in growth rate at the beginning and end of June, the 5th sowing shows an increasing growth rate at these times. It seems probable that the depressant factor, postulated by Balls and Holton, may be the differences in the respective environments of root and shoot; there would be no depressant factor if both these environments were optimum. Where, however, the shoot's environment is nearer the optimum than the root's environment, there is a disparity of growth, with a departure from the optimum root/shoot ratio. The cumulative effect of sub-optimal nutrient supply would be sufficient to account for the observed facts, and the necessity to presume a toxic effect is removed.

It will be noted that the reverse could also apply, namely, that a sub-optimal environment for the shoot, reducing assimilation through the leaves, would result in a less than optimum root growth, even if the root's environment were an optimum for root growth.

This cumulative effect of lessened nutrient supply has been discussed also in another paper (Trought 1930).

Turning to flowering curves (Diag. II), we find that there is a divergence from Balls and Holton's results. The commencement of flowering does not show throughout the same progressive shortening of interval after the sowing. The fifth sowing did not commence flowering till early August, while the first flowering of the other sowings commenced on the 27th May, 4th June, 17th June and the 26th June respectively. It will be seen that there is a definite early mode in the flowering curves of the three earliest sowings. The rise of this mode takes place at the time the growth curves are falling from the beginning to the end of June. The fall in the growth

curve mentioned earlier may thus be due not solely to the environment but also to the well-known phenomenon of an increasing competition of the opening flowering buds with the growing point for nutrient material. The subsequent increase in growth-rate with decreased maximum temperatures shows that the environmental effect is actually of considerable importance, as this increase occurs when the rate of flowering is also increasing. (Note :—The drop in growth on 19th June is a " duststorm " effect).

Turning to the curves showing the number of bolls opened per plant per day (Diag. III), we find that more bolls are produced by the fifth sowing, the total number of bolls recorded being 658, 358, 421, 630 and 705 for each sowing respectively.

In the bolling curves the main difference is shown by the 5th sowing which gave an increased boll production between the 1st and 19th November. These bolls were from flowers produced between the 14th and 27th of September. A reference to the flowering curves shows that there was a greatly increased flower production in the 5th sowing between those dates compared with other sowings.

1927 Experiment.

Early sowings on February 14th and March 1st were made, but germination was so poor in these beds that they were ploughed up and resown on April 15th, one set of beds being sown with 4F. and the other set with 285F.

The sowing of 285F. which should have been done on the 15th March was delayed until the 21st owing to a canal closure. 4F. was sown on April 1st.

The development curves for this experiment are of little interest, and have not been reproduced. The later sowings of both 4F. and 285F. grew more rapidly than the early sowings after the beginning of July but in the end the April 15th sowing of 4F. was the tallest of all; the April 15th sowing of 285F. did not grow to so great a total height as the March 21st sowing.

The flowering and bolling curves of all sowings were similar, the 4F. curves however being slower to rise than the 285F. The fluctuations on both curves run well together, the early sown cottons showing practically the same fluctuations as the later sown cottons. A similar concurrence is shown in flowering curves of different varieties. These fluctuations cannot be referred back to fluctuations in daily growth as a predetermining cause, nor have records of any one particular climatic condition been found which could be said to be the predetermining cause of daily flowering fluctuations.

The experiment happened to be sited in poor land, with a somewhat *kalarati* soil (" white alkali soil "). It shows that February 14th and March 1st sowings are too early and the records show that at these times the soil temperatures are too low for satisfactory germination, while there is a rapid increase in soil temperature to March 15th (See Table I). (No germination was obtained in tests in a room where the temperature was maintained at approximately 18°C. throughout.)

As far as flowering and boll production go, there is little difference between mid-March and mid-April sowings. The 4F. variety also is more tolerant of alkali soil than 285F.

TABLE I.

Mean soil temperatures at Lyallpur.

	At 5 cm. depth			At 30 cm. depth		
	1927	1928	1929	1927	1928	1929
February 14th . . .	15°C.	14·5°C.	12°C.	13°C.	14·0°C.	11·7°C.
March 1st	16°C.	..	18°C.	14°C.	..	16·7°C.
March 15th . . .	23°C.	17°C.*	25°C.	19·2°C.	18·2°C.	21·2°C.

* Two days after an irrigation.

1928 EXPERIMENTS.

In 1926 a single plot of 4F. cotton was sown on 7th July. The yield was unsatisfactory, but it was noticed that the habit of 4F., when sown as late as this, differed from the habit of the plant when sown at the ordinary time. Instead of the plant being bushy and spherical in outline with very numerous monopodial branches on which the bolls were borne, it was conical in outline ; the main stem was not checked in its early growth, and bore sympodia at its lower nodes. There were only a few sturdy spreading monopodia at the base of the plant.

In the autumn of 1927 it was noticed that 4F. grown at Sakrand in Sind showed this characteristic habit of growth both in earlier sown and later sown crops. The earlier sown crop however had not this appearance so well defined. The later sown crop was sown on the 1st of June and gave good boll opening with the bolls borne low down on the plant. It was also not appreciably later than the earlier sown crop.

Observations in zemindars' fields in the autumn of 1927 in the Lower Bari Doab Colony also seemed to show that an advantage might be gained by sowing as late as the middle of June. The experience of the British Cotton Growing Association farm at Khanewal also indicated that late sowing was profitable. [See Roberts, 1929 (*a*) and (*b*).]

It was decided therefore to include a sowing in the middle of June in the 1928 experiments and sowings were made on April 1st, May 1st, and 12th of June with 4F.

The seed was sown on ridges 2′ 6″ apart, at a distance of 14″ along the ridge. The ridges were watered and 15-20 seeds dibbled in each hole when the land came into condition. Germination in all beds was satisfactory. Resowing was done where

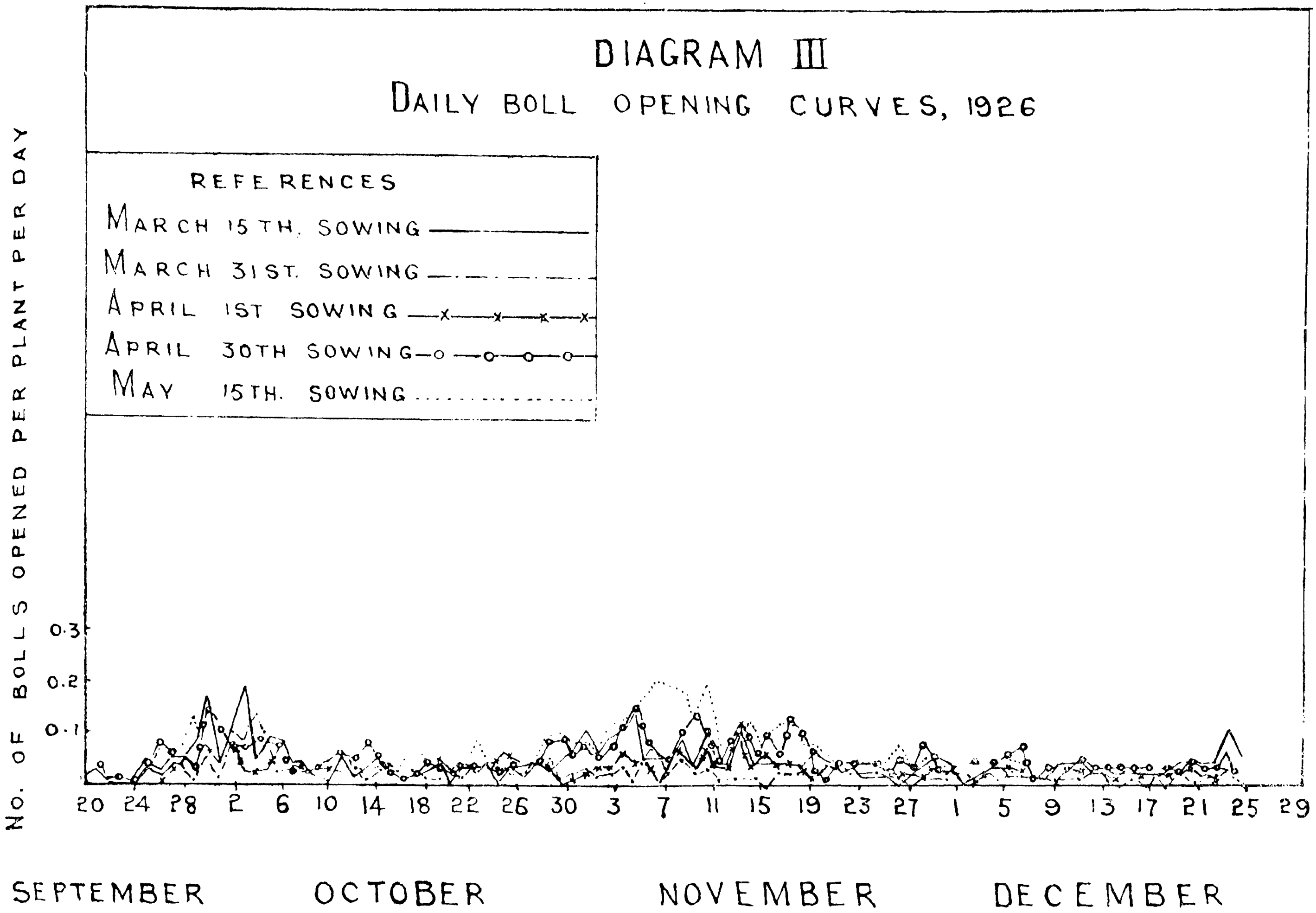
DIAGRAM III
DAILY BOLL OPENING CURVES, 1926
REFERENCES
MARCH 15TH. SOWING
MARCH 31ST. SOWING
APRIL 1ST SOWING
APRIL 30TH SOWING
MAY 15TH. SOWING
NO. OF BOLLS OPENED PER PLANT PER DAY
0·3
0·2
0·1
20 24 28 2 6 10 14 18 22 26 30 3 7 11 15 19 23 27 1 5 9 13 17 21 25 29
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER

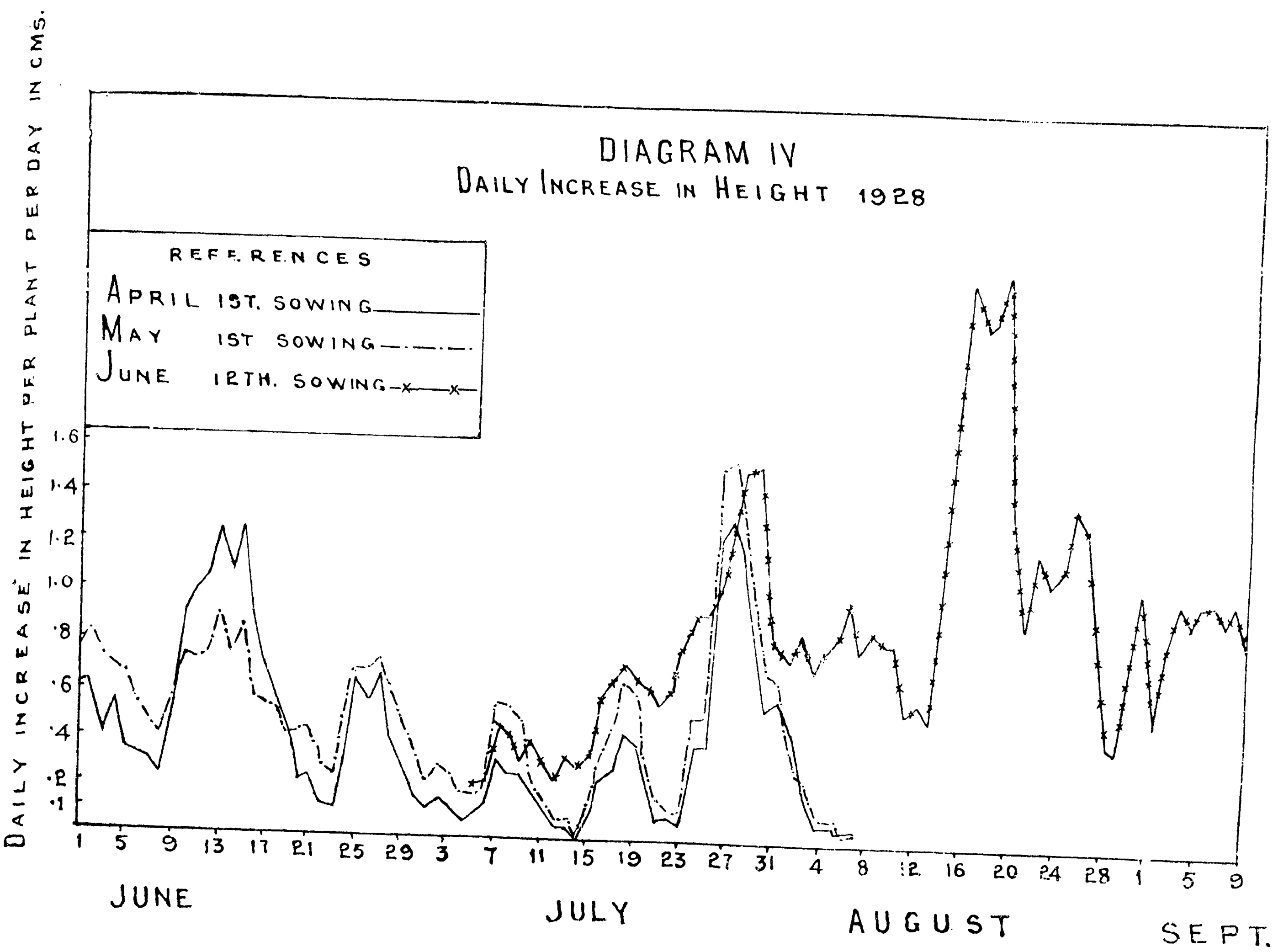
DIAGRAM IV
DAILY INCREASE IN HEIGHT 1928
REFERENCES
APRIL 1ST. SOWING
MAY 1ST SOWING
JUNE 12TH. SOWING
DAILY INCREASE IN HEIGHT PER PLANT PER DAY IN CMS.
1.6
1.4
1.2
1.0
·8
·6
·4
·2
·1
1 5 9 13 17 21 25 29 3 7 11 15 19 23 27 31 4 8 12 16 20 24 28 1 5 9
JUNE
JULY
AUGUST
SEPT.

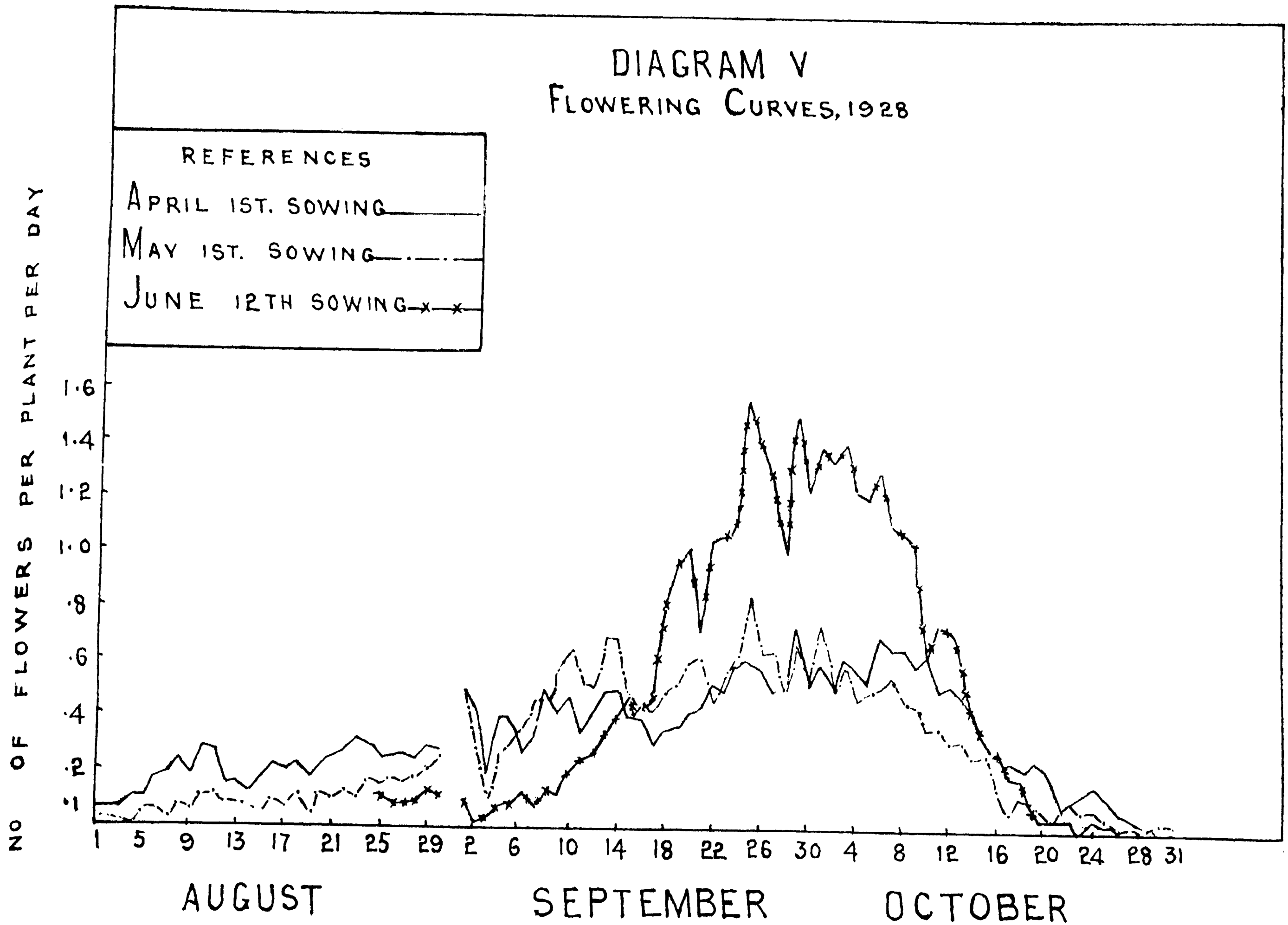
DIAGRAM V
FLOWERING CURVES, 1928
REFERENCES
APRIL 1ST. SOWING
MAY 1ST. SOWING
JUNE 12TH SOWING
NO OF FLOWERS PER PLANT PER DAY
·1
·2
·4
·6
·8
1·0
1·2
1·4
1·6
1
5
9
13
17
21
25
29
2
6
10
14
18
22
26
30
4
8
12
16
20
24
28
31
AUGUST
SEPTEMBER
OCTOBER

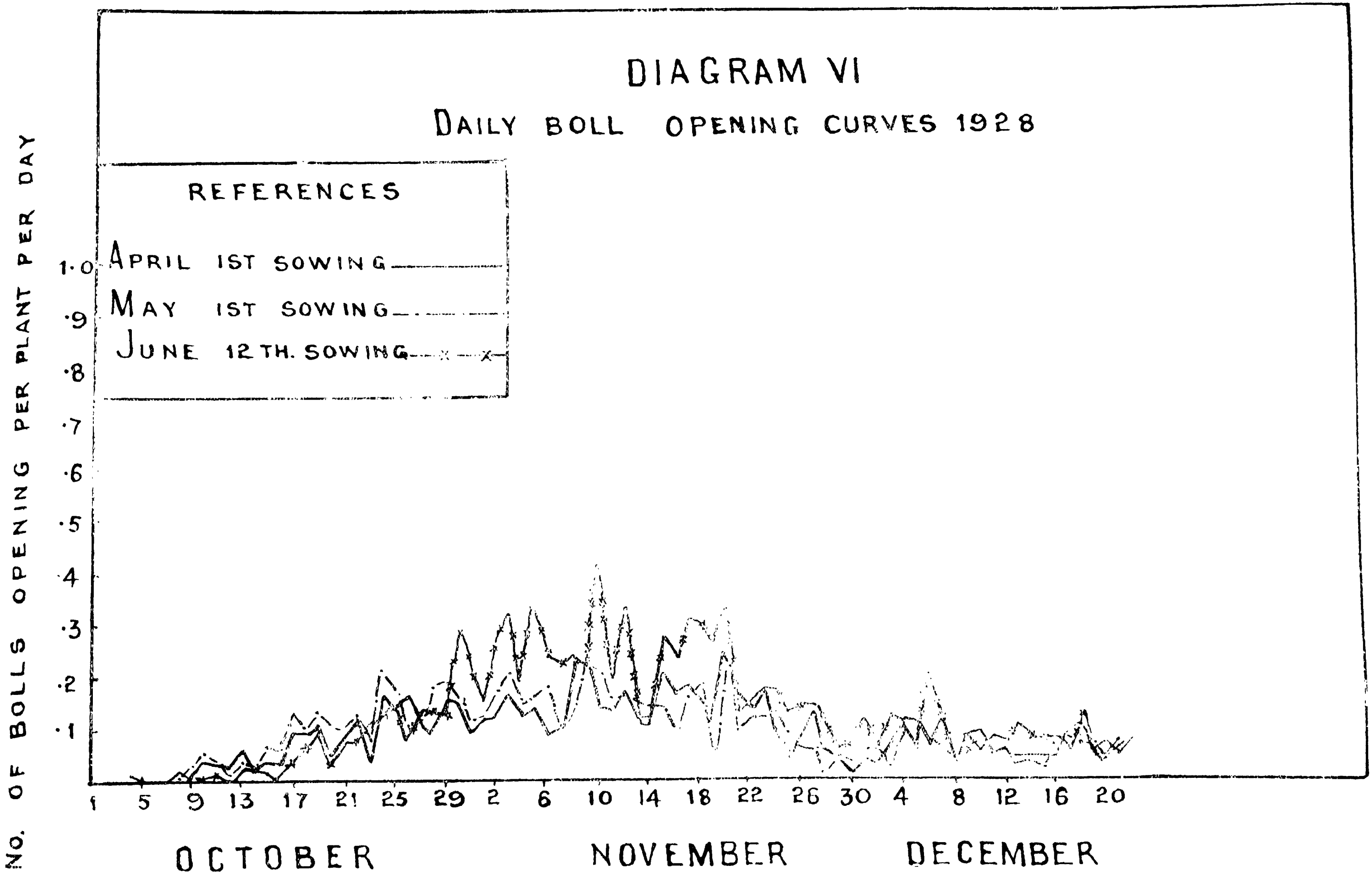
DIAGRAM VI
DAILY BOLL OPENING CURVES 1928
REFERENCES
APRIL 1ST SOWING
MAY 1ST SOWING
JUNE 12TH. SOWING
NO. OF BOLLS OPENING PER PLANT PER DAY
1·0
·9
·8
·7
·6
·5
·4
·3
·2
·1
1
5
9
13
17
21
25
29
2
6
10
14
18
22
26
30
4
8
12
16
20
OCTOBER
NOVEMBER
DECEMBER

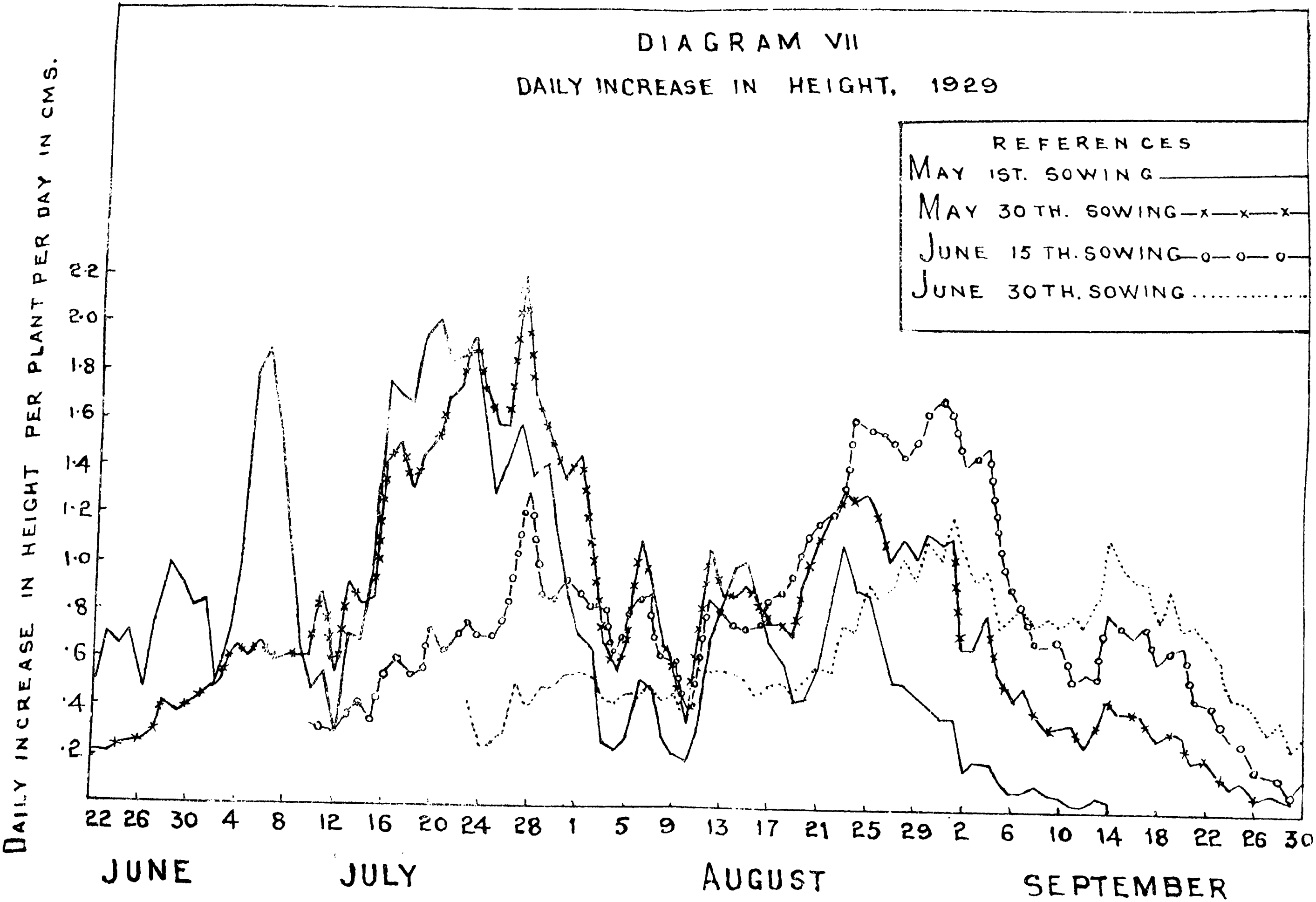
DIAGRAM VII
DAILY INCREASE IN HEIGHT, 1929
REFERENCES
MAY 1ST. SOWING
MAY 30TH. SOWING
JUNE 15TH. SOWING
JUNE 30TH. SOWING
DAILY INCREASE IN HEIGHT PER PLANT PER DAY IN CMS.
2·2
2·0
1·8
1·6
1·4
1·2
1·0
·8
·6
·4
·2
22 26 30 4 8 12 16 20 24 28 1 5 9 13 17 21 25 29 2 6 10 14 18 22 26 30
JUNE
JULY
AUGUST
SEPTEMBER

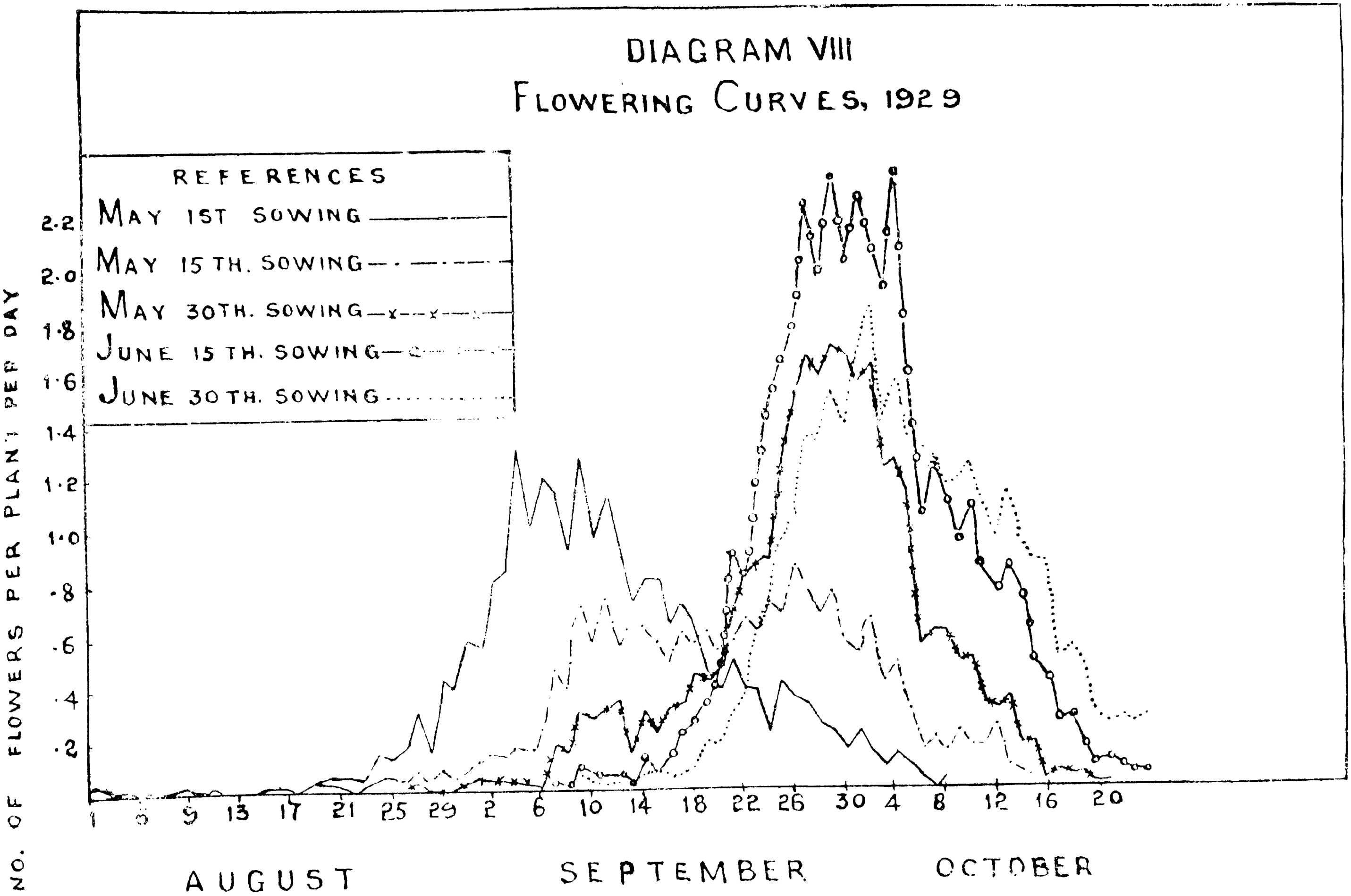
DIAGRAM VIII
FLOWERING CURVES, 1929
REFERENCES
MAY 1ST SOWING
MAY 15TH. SOWING
MAY 30TH. SOWING
JUNE 15TH. SOWING
JUNE 30TH. SOWING
NO. OF FLOWERS PER PLANT PER DAY
2.2
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
1
5
9
13
17
21
25
29
2
6
10
14
18
22
26
30
4
8
12
16
20
AUGUST
SEPTEMBER
OCTOBER

The development curves are given in Diagrams VII, VIII and IX. It will be seen that in this year there are considerable differences in the type of growth between the different sowings. The first and third sowings grew much more rapidly than the fourth and fifth sowings up to the beginning of August. From the 20th of August there was a recrudescence following the rains which occurred between the 21st and 28th of that month. This stage may actually be considered as the main period of growth for the fourth and fifth sowings, and the fourth sowing grew most rapidly. Growth in the first sowing falls away rapidly and no growth takes place after the middle of September. Growth, however, continues in the other sowings till the end of September.

In the flowering curves there are considerable differences from 1928. The first and second sowings have their period of maximum flower production earlier than third, fourth and fifth sowings. The third, fourth and fifth sowings produce practically the whole of their flowers between the middle of September and the middle of October. The fourth sowing has in 1929 again produced considerably more flowers than other sowings.

These differences in the flowering curves are reproduced in the bolling curves. The first, second and third sowings open their bolls earlier than the two later sowings. (It will be noted that after December 24th boll counting was only carried out weekly.) The total number of bolls opened per plant are shown in the table below and it will be noted that the 4th sowing again gives the maximum number of bolls per plant.

Average number of bolls per plant in 1929.

1st sowing	2nd sowing	3rd sowing	4th sowing	5th sowing
8·9	7·2	8·9	9·5	7·9

Discussion.

Roberts' (1929) results together with the 1928 and 1929 sowing date records seem to point to the conclusion that a sowing date later from that which has usually been accepted as normal could profitably be adopted by the ordinary zemindar. It seems clear also that sowing as late as July 1st is not profitable, and the first half of June is probably the optimum date. March and April sowings have definite disadvantages such as the difficulty of water supply for sowing, etc., as compared with a June sowing, nor is there any advantage in yield.

There are several advantages in June sowings. Elsewhere (Trought 1930) it has been shown that during May and the early part of June environmental conditions can be so severe as to cause serious detriment to the plant in its later development. By sowing in June this severe period is avoided.

Second, there is greater probability of the plant being able to develop unchecked (though in both years 1928 and 1929 there were checks to growth at the beginning of August) owing to the gradually decreasing severity of the environment from early June onwards. At the time when vegetative growth is being made the conditions are more favourable for June-sown cottons. As a result of the later flowering of June-sown cottons, the flowering period is after the time when the anthers dehisce so that the flowers are produced and fertilised normally. This has been shown (loc. cit.) also to be advantageous.

Third, the later sowing enables more time to be given to the preparation of the land for the crop. This, in view of the prevalent practice of sowing cotton immediately after wheat, is eminently desirable.

Fourth, the smaller size of the plant during July, when heavy rains are likely to occur, causing puddling and lack of aeration of the soil, enables cultivations to be undertaken later, and at a time when cultivations appear to be most necessary.

SUMMARY AND CONCLUSIONS.

The results of experiments with different sowing dates of Punjab-American cotton are presented and discussed. Diagrams of daily growth, daily flowering and daily bolling are given.

It is suggested that differences from the optimum between the root's and shoot's environments may account for the differences found between different sowing dates, by inducing a sub-optimal root/shoot ratio, which has a cumulative effect throughout development (cf. Balls and Holton 1915).

The general conclusion is drawn that cotton sown late has a greater rate of growth and an increased flower and boll production, and that sowing between 1st and 15th June can safely be recommended as a general practice.

Some practical advantages of this later sowing are discussed.

ACKNOWLEDGMENTS.

These experiments were carried out as part of the Indian Central Cotton Committee's Punjab Research Scheme (Botanical), in conjunction with the Punjab Government, and I am indebted to Mr. B. C. Burt for reading through the typescript and making suggestions.

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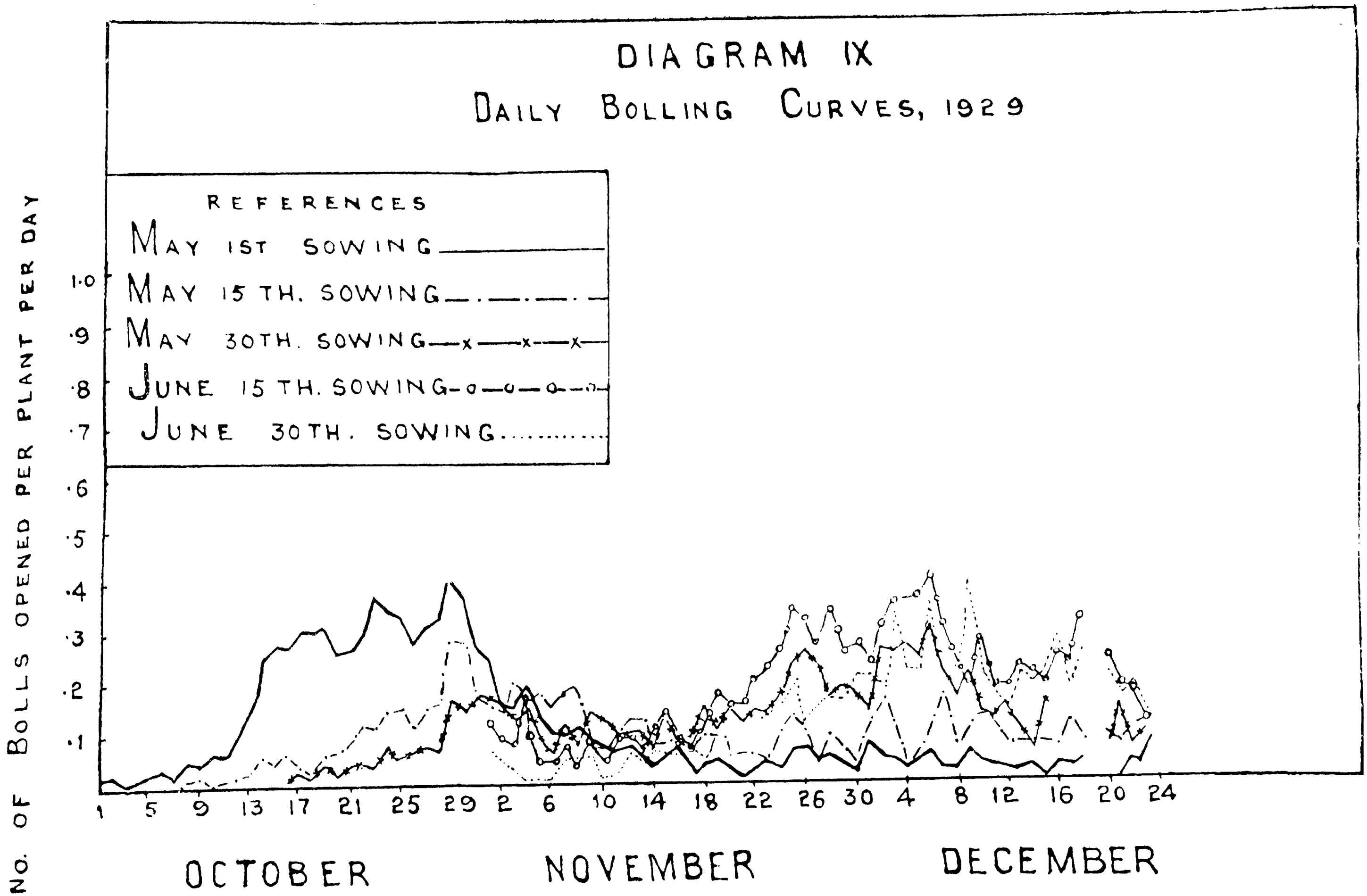

DIAGRAM IX
DAILY BOLLING CURVES, 1929
REFERENCES
MAY 1ST SOWING
MAY 15TH. SOWING
MAY 30TH. SOWING
JUNE 15TH. SOWING
JUNE 30TH. SOWING
1·0
·9
·8
·7
·6
·5
·4
·3
·2
·1
NO. OF BOLLS OPENED PER PLANT PER DAY
1 5 9 13 17 21 25 29 2 6 10 14 18 22 26 30 4 8 12 16 20 24
OCTOBER
NOVEMBER
DECEMBER

BIBLIOGRAPHY—*contd.*

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SUGGESTED METHOD OF STUDYING SUGARCANES FOR BREEDING WORK.*

BY

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AND

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I. Introduction.

The extant studies of sugarcane varieties consist largely of descriptions of morphological and such other characters as juice quality, disease resistance, period of maturity and, in certain instances, of the conditions under which the particular variety is able to flourish. Such studies have been of undoubted use in the selection of varieties to suit particular conditions.

The experience gained at the Imperial Sugarcane Breeding Station at Coimbatore has recently emphasized the utility of a somewhat new line of studies—on the physiology and development phases of sugarcanes—in the breeding of seedlings for a given set of conditions. Such studies are more time-consuming and laborious but would appear to be fully justified by the valuable indications resulting therefrom. By way of illustration, the early life-histories of three canes—one indigenous Indian cane and two Coimbatore seedlings—are briefly described in this paper.

II. Varieties studied.

The canes studied in this paper are *Katha*, *Co. 205* and *Co. 285*. *Katha* is a cane indigenous to the Punjab and, while possessing certain valuable characters, is one of the most primitive of the Indian kinds. *Co. 205* was obtained by crossing a 'noble' cane, *Vellai*—considered to be rather similar to *Lahaina* of Hawaii—with the *Saccharum spontaneum* found at Coimbatore in South India. *Co. 285* is a seedling one parent of which was a *Green Sport* of the variety known as *Striped Mauritius* in South India. This *Green Sport* is a cane of the 'noble' type. The male parent of this seedling is not certain but there is little doubt that it is neither *Green Sport* selfed nor a hybrid with another 'noble' type of cane. It was quite different from the usual type of seedlings obtained from *Green Sport* and is

* Paper read at the 17th Meeting of the Indian Science Congress, Allahabad, January 1930.

suspected to be a natural cross with a Coimbatore *Saccharum spontaneum* hybrid—either *Co. 205* or *Co. 206*.

Co. 205 has been successfully replacing *Katha* at least in the unirrigated tracts of the Punjab, and *Co. 285* would appear to be an improvement on *Co. 205*. In the opinion of Sirdar Sahib Kharak Singh, Deputy Director of Agriculture, Gurdaspur, "it is going to replace *Co. 205*....... It has all the good points of *Co. 205* but at the same time free from its defects............" In the language of Java experts *Co. 285* would be an *ennobled Co. 205*.

The development studies of these three canes, up to and inclusive of twenty weeks* from time of planting, are described ; and an attempt is made to find, in the growth phases, an explanation for the better performance of the two Coimbatore eedlings under Punjab conditions.

III. Study of sett roots.

(1) *Number and rapidity of development.*

One of the first activities in the planted sugarcane setts is the development of roots [1] (*sett* roots) from the incipient or resting root tips—termed *root eyes*—found on each cane joint. The number of such root eyes varies in different varieties and similar differences were noticed in the three canes under study, the largest number being in *Co. 285* (Table I). Sugarcane varieties differ also in the manner and rapidity of development of roots from these root eyes. On the whole the *noble* canes show a tendency to develop roots from all or most of their root eyes at an early stage. In the three varieties *Katha* was found to develop roots at an early stage and from the bulk of its root eyes. In *Co. 205*, on the other hand, the development is more gradual (Table I). The same differences were noticed under ordinary field conditions as well as in sand culture.

TABLE I.

Number and rapidity of development of sett roots.

Variety	Number of root eyes on each joint (Average of 21 counts)	Percentage of sett roots developed (average of 10 counts)		
		15th day	25th day	35th day
Katha	33·8	90·0	95·3	96·6
Co. 205	38·6	89·5	89·9	97·9
Co. 285	42·1	72·6	88·6	91·3

* Twenty weeks from time of sowing covers a rather critical period for sugarcanes in the Punjab.

[1] For detailed descriptions of sett and shoot roots *vide Mem. Dept. Agri. India, Bot. Ser.*, Vol. XVI, No. 5, January 1929 : "Studies of Sugarcane Roots at different stages of Growth," by Rao Bahadur T. S. Venkatraman, B.A., and R. Thomas.

(2) *Functioning period.*

In sugarcanes the *sett* roots function only for a time, their place being taken up later by other roots which develop from the growing shoots and termed *shoot* roots. It has been noticed that in the Coimbatore form of *Saccharum spontaneum*, the *sett* roots function for a comparatively long period, even after the development of the *shoot* roots. *Sett* roots were found to cease functioning earliest in *Katha*—between the 20th and the 25th days. In *Co. 205* and *Co. 285* they were observed to be functioning even after 49 days, *Co. 205* showing a greater amount of *sett* root activity than *Co. 285* at the end of that period. The longer functioning period of *sett* roots in the two Coimbatore seedlings is apparently derived from their *Saccharum spontaneum* parentage.

With the help of a method evolved at Coimbatore by R. Thomas,[1] it has recently become possible to grow sugarcane plants on *sett* roots alone. The three canes were grown in this manner and it was found that whereas *Katha* showed a distinct yellowing—owing to the non-availability of shoot roots—the two Coimbatore seedlings showed better health (Plate XIX). *Co. 285* was greener and more vigorous than Co. *205*, indicating that the *sett* roots of *Co. 285* are superior to those of *Co. 205*.

IV. Study of Shoot Roots.

As already mentioned, the *sett* roots in a growing cane cease to function after a time and their place is taken up by *shoot* roots. The further growth of the plant, including tillering, would appear to depend upon the vigour of growth of *shoot* roots.

Katha was the earliest to develop *shoot* roots, these being produced as early as between the 10th and 13th day. *Co. 205* develops its *shoot* roots about the 25th day and *Co. 285* about the 21st day. The tillering of the three varieties at four weeks was 2·6 for *Katha* and in the neighbourhood of 1·0 for *Co. 205* and *Co. 285*. There is thus a correlation between early tillering and early shoot root development in the three varieties.

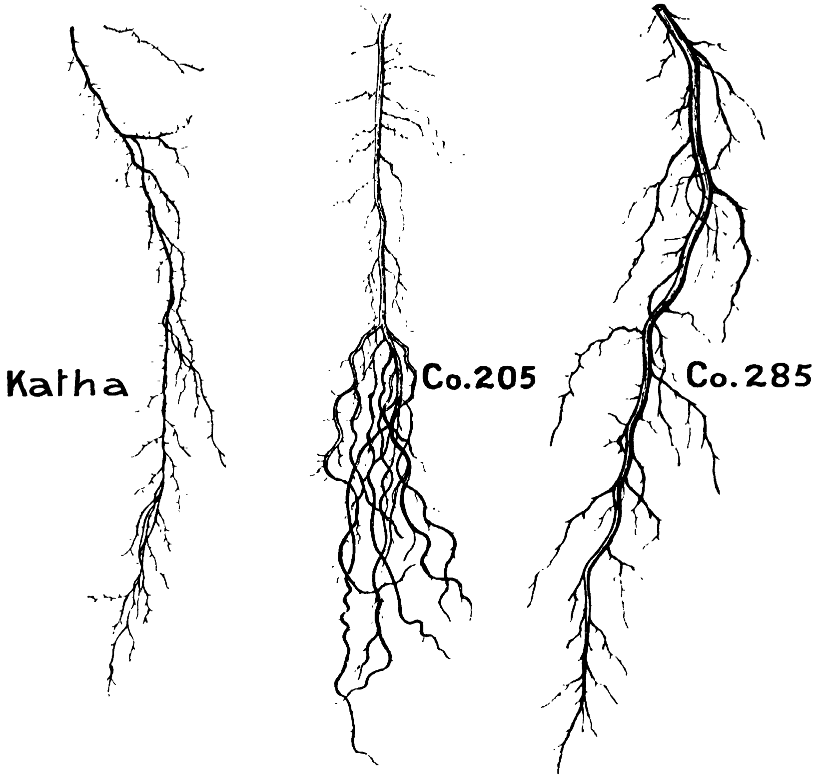
Like the *sett* roots the *shoot* roots also function only for a time, their place being taken by other shoot roots. This results in a series of flushes of fresh roots—*shoot* roots—from the growing plants. Interesting differences were noticed between the three varieties in the interval between the flushes of shoot root development. In the present case the studies were carried only up to 35 days from sowing and the results are given in Table II. The series of root developments were found to be at the shortest intervals in *Katha* and at the longest intervals in *Co. 205, Co. 285* occupying an intermediate position in this respect. Table II gives the tillering of the three varieties at the end of sixteen weeks from sowing; and there is found a positive correlation between the rapidity of root development and early tillering.

[1] Thomas, R. A Method of studying the roots of Sugarcane. *Agri. Jour. India*, Vol. XXII, Pt. 2, p. 138.

Grown on Sett roots alone
(20 weeks)

Katha

Co. 285


Katha
Co.205
Co.285

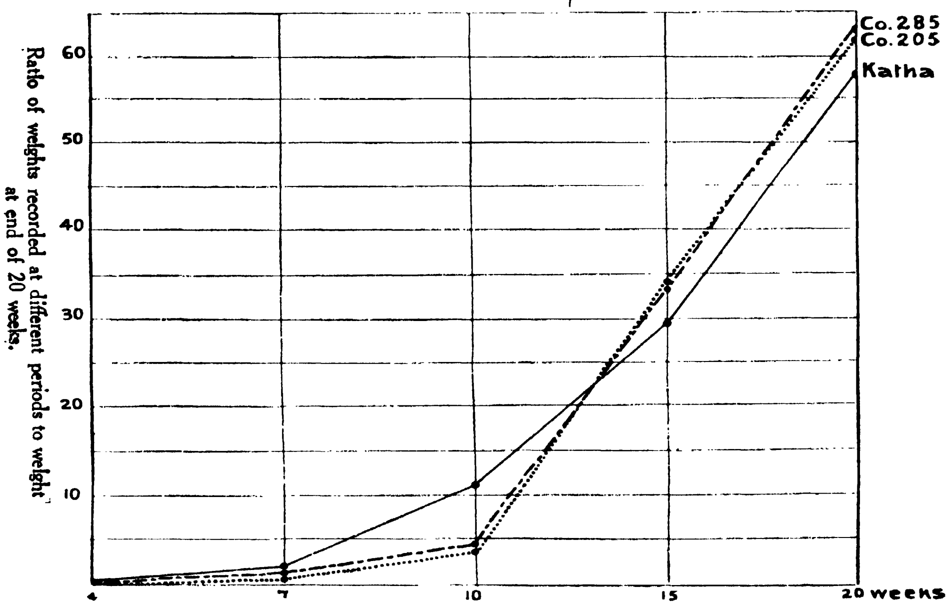

Ratio of weights recorded at different periods to weight at end of 20 weeks.
60
50
40
30
20
10
4
7
10
15
20 weeks
Co. 285
Co. 205
Katha

TABLE II.

Shoot root development and tillering.

Variety	Number of flushes of shoot roots produced in 35 days	TOTAL NUMBER OF SHOOT ROOTS (AVERAGE OF 10 COUNTS)			Number of living shoots per plant at the end of 16 weeks (average of 10 counts)
		15th day	25th day	35th day	
Katha . . .	Three	1·5	17·4	20·7	27·1
Co. 285 . . .	Two	*Nil*	2·4	6·0	17·0
Co. 205 . . .	One	*Nil*	1·7	4·2	6·2

V. ROOT DIFFERENCES.

Interesting differences were noticed between the roots of the three varieties in thickness as well as in the mode of branching (Pl. XX). The roots of *Katha* were slender and finely branched, particularly near the base. The roots of *Co. 205* were thicker than those of *Katha* and showed the branching particularly at tips. The roots of *Co. 285* were as thick as those of *Co. 205* with long thick branches all over. The roots of the Coimbatore seedlings would appear to be better adapted to penetrate harder soils on account of their thickness and vigour of growth.

Indications were also noticed in the histological structure of these roots, the Coimbatore seedlings appearing to possess better adaptations for protection against drought.

VI. STUDY OF SHOOT DEVELOPMENT.

(1) *Bud germination.*

Differences were noticed in the germination of buds in the three varieties. *Katha* germinated the earliest and *Co. 285* the tardiest. Germinations up to the end of the third week are given in Table III.

TABLE III.

Rapidity of bud germination.

Variety	PERCENTAGE OF GERMINATION AT THE END OF		
	First week	Second week	Third week
Katha	100	..	..
Co. 205	36	65	95
Co. 285	15	45	65

(2) *Movements of shoots.*

In certain sugarcane varieties the main shoot after germination gradually moves away from the vertical, dipping ultimately below the horizontal in certain cases.[1] At a subsequent stage the shoots erect themselves more or less according to the variety. Under ordinary field conditions it is not possible to follow the bending and the subsequent erection of these shoots. By a method evolved by R. Thomas and already referred to, it is now possible to follow the bending and measure the angles at frequent intervals. This behaviour of the main shoot in the three varieties is diagrammatically represented in Pl. XXI. It will be seen that *Co. 205* dips the most and *Katha* the least, *Co. 285* occupying an intermediate position. The present studies have been followed for only twenty weeks from sowing, and the graph in Pl. XXI shows the curvature of the main shoot at different stages of growth.

The movement of the main shoot was found to be most rapid in *Co. 285* and least in *Katha*. Table IV gives the relative rapidity of movement in the three varieties. The daughter and grand-daughter shoots developing from the main shoot showed parallel differences. In the following Table the main shoot is termed 'A' shoot, the daughter shoots 'B' shoots and the grand-daughter shoots 'C' shoots.

TABLE IV.

Shoot movements of 'A,' 'B' and 'C' shoots.

Variety	Angle in degrees through which the shoot moved in seven days (average of 20 observations)		
	'A' shoot	'B' shoot	'C' shoot
Katha	3·0	3·7	3·8
Co. 205	4·0	3·9	3·9
Co. 285	5·5	4·4	5·7

The ultimate habit of the plant is directly dependent upon the erection of the various types of shoots.

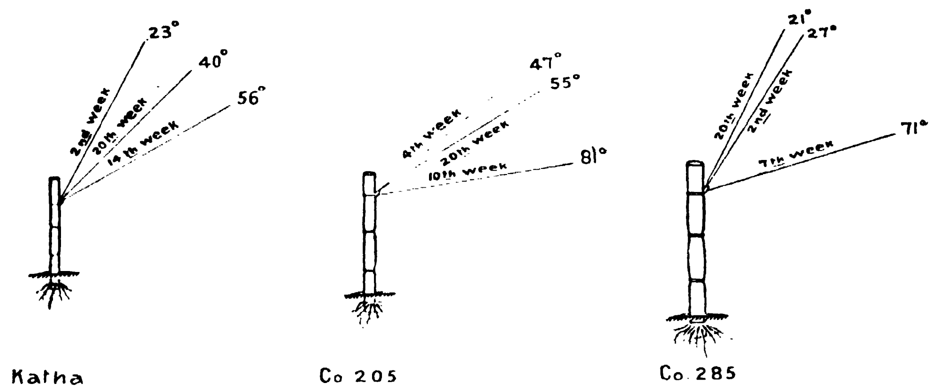
VII. THE GROWTH PERIODS.

Some time back a curious experience was reported to the junior author from the Government Agricultural Station at Gurdaspur in the Punjab. That year there was a change of management; and some little time previous to the advent of the monsoon (towards the end of June), the growth of *Co. 205* was so much behind that

[1] Barber, C. A. Studies in Indian Sugarcanes, No. 2. *Mem. Dept. Agri. India, Bot. Ser.*, Vol. VIII, No. 3, page 138.

Development of the main shoot

(deviation from the vertical - at different stages of growth.)



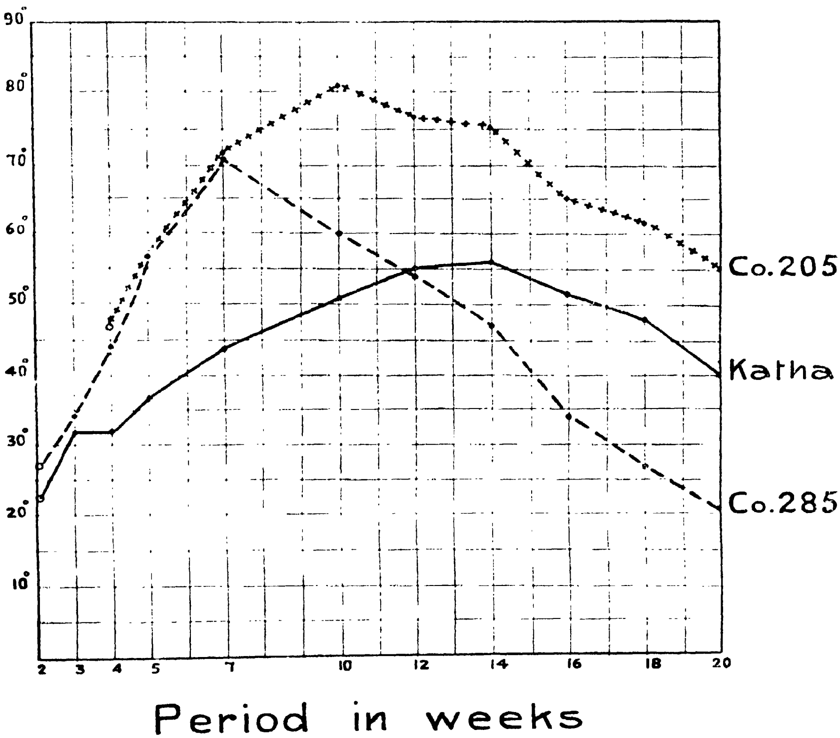
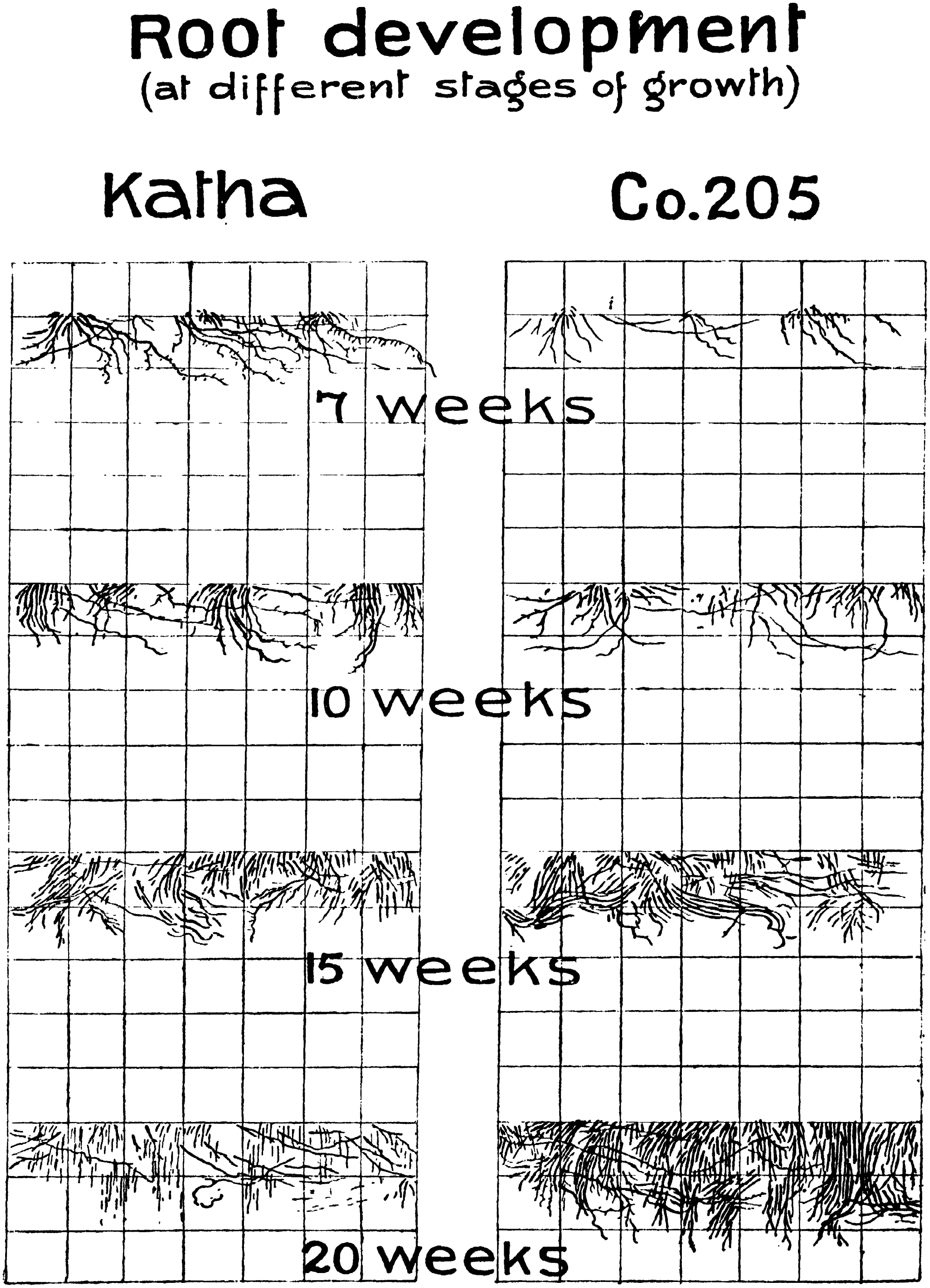


PLATE XXII.


Root development
(at different stages of growth)
Katha
Co.205
7 weeks
10 weeks
15 weeks
20 weeks

of *Katha*, that they were led to wonder if the published information about the superiority of *Co. 205* over *Katha* (*Vide* Leaflet No. 22 of 1923, Department of Agriculture, Punjab) might not need to be retracted. The monsoon came and in a short period *Co. 205* quickly gained over *Katha* in vegetative growth and kept it up to maturity.

This was interesting; and, though the same experience was recorded in subsequent years at Coimbatore as well, it was not possible at the time to go deeper into the question. In the present studies, weights were recorded periodically of the green above-ground shoot portions and the root systems carefully dissected and drawn to scale at each weighing. The record of weights is given in Table V.

TABLE V.

Shoot weights at different stages of growth. (Average of ten weighments.)

Variety	Weight in grams at end of				
	4th week	7th week	10th week	15th week	20th week
Katha	11·28	99·06	712·08	2,316·44	5,485·00
Co. 205	5·10	50·14	245·14	2,193·01	5,693·80
Co. 285	5·66	93·19	320·00	2,338·80	6,126·10

It will be noticed that whereas the weights of *Katha* are considerably higher than those of the Coimbatore canes up to the end of the tenth week, the figures are near one another at the end of the 15th week. At the end of the 20th week it is seen that the Coimbatore seedlings have gained a distinct march over *Katha*. The graph in Pl. XX is based on the percentage of the green weight to the same weight at the end of the 20th week at different stages of growth. At maturity the Coimbatore seedlings are easily superior to *Katha* in relative weight of growth both in the Punjab and at Coimbatore.

Pl. XXII gives the root systems of *Katha* and *Co. 205* at different periods. The root system of *Co. 205* is inferior to that of *Katha* at the end of seven and ten weeks. At the end of fifteen weeks it is about equal and rapidly gains over that of *Katha* at the end of twenty weeks. Here then is an explanation for the shoot growth curves of *Katha* and *Co. 205* above mentioned.

VIII. Discussion of Results.

The sugarcane planting season in the Punjab is about the middle of March. After planting the canes pass through comparatively unfavourable conditions for growth till the advent of the South-West monsoon towards the end of June. Roughly twelve to fourteen weeks from the time of planting might be considered rather a

critical period for the young cane plants under Punjab conditions. From the above studies it will be seen that the Coimbatore seedlings put up a rather thrifty growth during this period, unlike *Katha* which starts growth fairly early. When the South-West monsoon sets in towards the end of June, it finds the Coimbatore seedlings with a well established root system and ready to start development with the monsoon rains.

It is suggested that the two Coimbatore seedlings are better adapted to the Punjab conditions—at any rate in the unirrigated areas—on account of (1) the slower and more gradual development of *sett* roots, (2) the longer period of *sett* root development enabling the plants to tide over unfavourable conditions, (3) the longer functioning period of the *sett* roots, (4) the apparently greater efficiency of *sett* roots, (5) the tardier and later development of *shoot* roots, (6) the later tillering and (7) the thriftier development of the shoot system during the 'stress' period for canes in the Punjab.

It is not contended in this paper that Co. 205 was definitely and deliberately bred with these various objects in view. Co. 285 was, however, sent out for trial in the Punjab because of its similarity to Co. 205—a cane which had proved useful in the Punjab—in its growth phases; and the results so far fully justify the selection of Co. 285 for Punjab conditions. It is proposed to try and select future canes for the Punjab on the above basis. During the studies various other interesting differences were recorded but it has not been possible to pursue them to their logical conclusions.

There is at present a great deal of chance in the breeding and selection of sugarcane seedlings for particular tracts; and it is suggested that studies like the above might introduce greater certainty into sugarcane breeding.

A NOTE ON THE DIFFERENTIATION OF HAIRS FROM THE EPIDERMIS OF COTTON SEEDS.

BY

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In the "Cotton Notes" of *Tropical Agriculture*, Vol. VI, No. 12, p. 351, Dr. Harland, in discussing Turner's paper[1] on "Ginning Percentage and Lint Index, the Influence of Environment on Ginning Percentage, etc.," writes as follows: "Gulati (working in Turner's Laboratory) made some tests to determine whether the number of epidermal and hair cells do increase after fertilization of the ovule. From his results Turner thinks there can hardly be any doubt that the numbers of both epidermal and hair cells increase largely up to 3 or 4 weeks after the flowering date. This conclusion, however, is difficult to reconcile with Barritt's anatomical observations. If Barritt is correct that the hairs become constricted at any early period, it is clear that younger hairs could be recognized by differences in the degrees of constriction and thickening. Since there is no anatomical evidence that hairs in all stages of development exist, the balance of evidence must remain with Balls, who stated that 'there do not appear to be any further growth of epidermal cells into lint hairs after the first day, in spite of accepted statements to the contrary.'"

The following are the results obtained by the writer and included in Turner's paper :—

Age (days from flowering)	NANDYAL 14			PUNJAB-AMERICAN 4F			PUNJAB-AMERICAN 289F		
	HAIRS	ORDINARY CELLS		HAIRS	ORDINARY CELLS		HAIRS	ORDINARY CELLS	
	No. per seed	No. per seed	Diameter μ	No. per seed	No. per seed	Diameter μ	No. per seed	No. per seed	Diameter μ
1 . .	4,530	22,990	12	5,980	21,020	13	6,430	21,880	13
10 . .	10,050	34,890	17	..	..	..	12,540	42,520	21
13 . .	..	..	..	14,230	74,070	27	..	..	..
16 . .	..	..	..	..	..	..	19,560	68,940	25
21 . .	14,070	56,900	36	..	..	..	..	..	..
28 . .	16,420	50,600	38	25,090	113,460	30	23,770	84,150	33

(μ = 0.001 millimetre.)

[1] *Jour, Text. Inst.*, XX, 9, pp. T233-273 (Sept. 1929).

As Turner remarks, "from the method of calculation it is evident that the figures in this table can only be regarded as very approximate. However, in spite of this, there can hardly be any doubt that the numbers of both epidermal and hair cells increase largely up to 3 or 4 weeks after the date of flowering. From these values it also appears that the increase in the number of hairs is roughly proportional to the increase in the number of epidermal cells. It may be observed that the number of hairs 28 days after flowering is much larger than that determined by other methods described later (Section VI); this may no doubt be accounted for by the fact that in the present method no distinction is made between lint hairs and fuzz hairs, both being reckoned simply as hairs".

Further evidence has since been obtained that the number of hairs increases after fertilization of the ovule, by making surface counts of the number of fibres. In order to do this, hairs were counted on corresponding pieces of seed-coat peeled off from a one-day old ovule and a ripe seed. In the case of the ripe seed the hairs were clipped off by a pair of scissors, or by passing it over a flame so as to leave very small lengths of hairs on the surface. The hairs were counted under the low power of a microscope in a field of known area. The total number of hairs on the seed was then calculated from the mean lengths of the axes of the seed measured before peeling off the seed-coat. The following values were obtained from one-day old ovules and ripe seeds of Nandyal 14 :—

No. of seeds	No. of hairs per seed	
	One-day old	Ripe
1	1,665	19,900
2	2,820	16,115
3	1,554	14,243
4	1,898	12,757
5	3,102	14,030
Mean	2,208	14,809

The disparity in these mean values is indicative of increase in the number of hairs.

Apart from this evidence of increase in the number of hairs, certain histological evidence has now been obtained bearing on the same point, from the examination of ovules of *Gossypium sanguineum* × *cernuum*, grown at the Technological Laboratory.

(1) Epidermal cells have been observed in process of division; mitotic figures of the nucleus have been seen in first day, fourth day, seventh day, and tenth day ovules. The presence of dividing cells implies multiplication of their numbers.

(2) Hair cells of greatly different lengths have been observed in close proximity to one another; some appear to have just sprouted, and others to have sprouted some time previously: the contrasting lengths have been observed in sections of

ovules of different ages. Although alternative explanations are possible, the differences in the lengths of these new out-growths are suggestive of age-differences between them, and therefore of the differentiation of new hairs in older seeds. It may also be noted that, in addition to single out-growths on the seventh day and tenth day ovules, there were many cases of two, three, and four adjacent hair cells sprouting simultaneously in a group.

(3) Observations on the bases of hair cells lead to the conclusion that the constrictions are by no means more pronounced in the 20th day seed than they are in the 10th day seed; and that it is not possible to utilize the constrictions, as Harland suggests, for determining the ages of the hairs.

Camera lucida drawings (Figs. 1—3) from a tenth day seed and seventh day seed are appended to show (1) a dividing epidermal cell, (2) different lengths of adjacent hairs, and (3) out-growth of hair cells in groups.

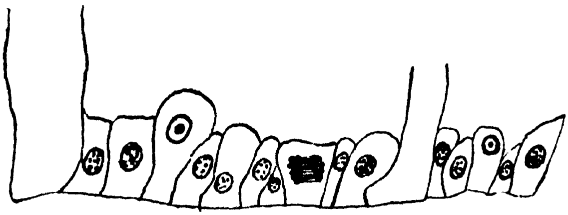

FIG. 1 × 500

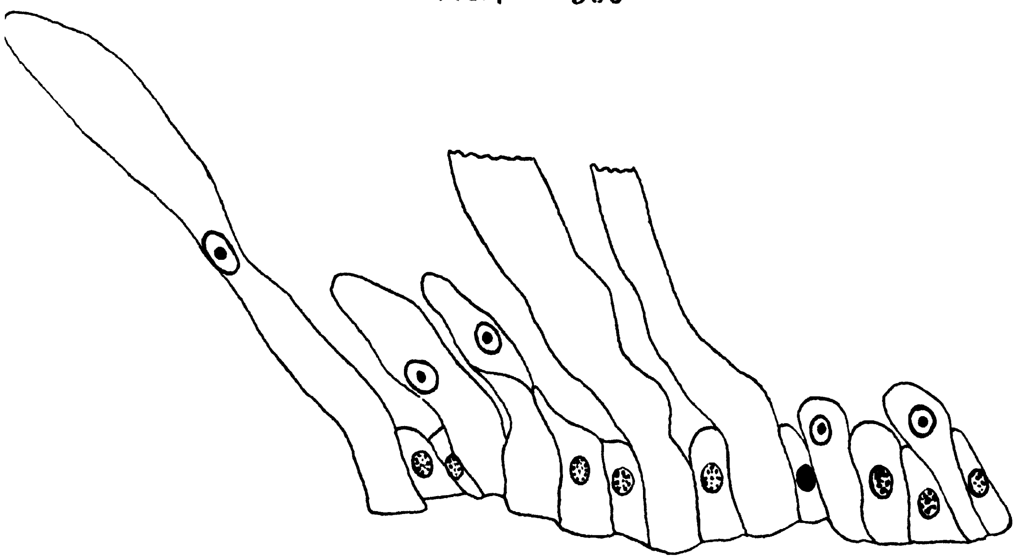

FIG. 2. × 500

Drawings from 10th day seed.

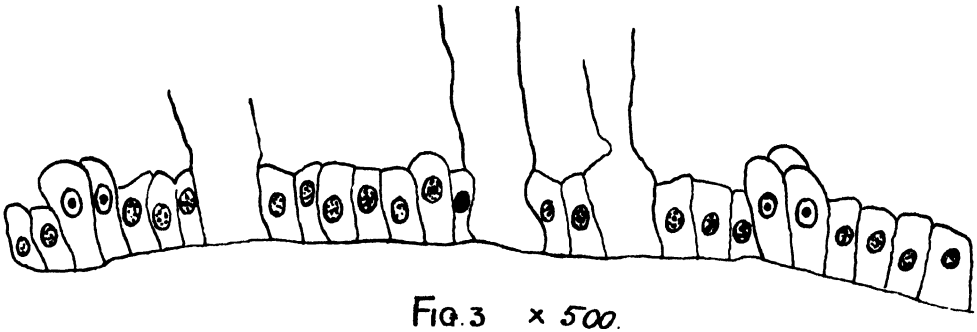

FIG. 3 × 500.

Drawing from 7th day seed.

TRACTOR IMPLEMENTS TRIED AT THE LYALLPUR EXPERIMENTAL FARM.

BY

D. P. JOHNSTON, A.R.C.Sc.I., N.D.A.,
Assistant Director of Agriculture, Punjab.

WHEN tractor cultivation was first started at Lyallpur in 1920 a certain number of implements were purchased. There was nothing then to go upon except the recommendations of the manufacturers or agents that the implements purchased were suitable for Punjab conditions. Since then we have had ample opportunity to try all the implements purchased and many others besides. A list of those tried together with the name of the agent or manufacturer of each, and the price paid, is given below :—

Name of implement	Manufacturer	Agent	Price Rs.	A.
1. Three-furrow self-lift plough 120-A.	International Harvester Co., Chicago, U. S. A.	Messrs. Volkart Brothers, Lahore.	445	8
2. Two-furrow self-lift plough .	Ransomes, Sims & Jefferies, Ltd., Ipswich.	Messrs. Duncan, Stratton & Co., Lahore.	640	0
3. Two-furrow non-self-lift plough.	Ditto .	Ditto .	610	0
4. Two-furrow disc plough, non-self-lift.	Ditto .	Ditto .	400	0
5. Grand Detour 5-disc self-lift plough.	J. I. Case Threshing Machine Co., U. S. A.	Messrs. Greaves, Cotton & Co., Lahore.	1,100	0
6. Ransomes "Orwell" cultivator, 11-tined.	Ransomes, Sims & Jafferies, Ltd., Ipswich.	Messrs. Duncan, Stratton & Co., Lahore.	510	0
7. Tandem disc-harrow, 32 discs	International Harvester Co., Chicago, U. S. A.	Messrs. Volkart Brothers, Lahore.	556	12
8. Spring-tined harrow . .	....	Ditto .	200	0

1. *A three-furrow self-lift plough* manufactured by the International Harvester Co., Chicago, U. S. A., was purchased in 1920. Since that time it has been worked by many tractors in all the different kinds of soils found at Lyallpur and has

almost invariably given satisfaction. It is provided with disc-coulters, which enable it to cut a clean furrow when burying green manure, or ploughing lands covered with sugarcane leaves, which is a great advantage. Its main drawback is that the share points cannot be depressed; consequently when the shares become a little worn the plough is inclined to come out of the ground. This difficulty can only be overcome by continually sharpening the shares, by heating and drawing them out on an anvil. Of all the ploughs tried here, it disturbs the level of the land least, and if it is properly adjusted, not more so than an ordinary Raja plough. The depth of ploughing can be varied from 4″ to 12″ as required. The self-lift arrangement which is operated by the tractor driver is very simple and works very satisfactorily. With whatever tractor used, one man has always been able to operate both the tractor and the plough with ease. An improvement could be effected if the shares were made to dip, or if reversible bar points were fitted. The bar points would make the plough much more economical to work as the shares would then last longer than they now do. The shares at present cost Rs. 15 each and will last for about 100 acres before replacement becomes necessary.

2. *A two-furrow self-lift plough* manufactured by Ransomes, Sims & Jefferies, Ltd., Ipswich, was purchased in 1921. It has been used with both the Austin and Cletrac tractors (each rated 12-20 H. P.), neither of which was found capable of continuously pulling a three-furrow plough at more than 5 inches depth. For ordinary ploughing it has been found that a three-furrow plough can do the work much more economically than a two-furrow one can. The beam is rather light and became bent on one occasion. The self-lift lever is also not well placed for manipulation from a tractor seat and unless the driver is placed well back he cannot operate the self-lift mechanism. The shares of this plough are made to "dip" so that it can be adjusted to hold its depth in any kind of soil. It worked quite well in the Lyallpur soils but would probably be too light for the black cotton soils found in the Central Provinces.

3. *A two-furrow non-self-lift plough* was purchased in 1921. It was tried for a short time only; as owing to its not having a self-lifting arrangement an extra man had to be provided to work it and again the loss of time at the headlands in lifting it out of, and lowering it into, the furrow was excessive; so much so, that it was found possible to do only about two-thirds of the area that could be done with the self-lift type of plough. Experience gained has shown that it is simply a waste of time to use non-self-lift ploughs.

4. *A two-furrow disc-plough,* manufactured by Ransomes, Sims & Jefferies, Ltd., Ipswich, was purchased in 1918. It was intended to use this plough with bullocks but the draught was found rather heavy for them. When the tractors came along we had no tractor disc-plough available, so this implement was converted to use with a tractor. Our main idea in using it with the tractor was to compare its work with that of a furrow-turning plough. A little experience showed that the disc-plough was inclined to disturb the level of the soil more than the fur-

row-turning type. Also that it would not keep its depth in hard soils ; in fact it was almost impossible to get it to enter into hard soils even when heavily weighted. It is not considered suitable for hard lands.

These ploughs were first introduced in America to get over the difficulty of breakages which were so common in root and stone infested lands. The disc-plough simply runs over all such obstacles or goes through them with little or no damage to itself, whereas if a furrow-turning type strikes a large stone or root, the share or some other part usually breaks, which considerably increases the cost of ploughing.

An effort was made to compare the cost of ploughing by the disc and furrow-turning types ; the results obtained showed that there was little to choose between them. A draught test was not made as we had no recorder for the purpose.

Disc-ploughs pulverise the soil and stir it up better than the furrow-turning type but they are much more difficult to adjust and operate.

5. *A Grand Detour 5-disc self-lift plough*, manufactured by the Case Threshing Machine Co., was purchased in 1926. The agents informed us that it was designed for use with the Case tractor but a very short trial in the Lyallpur soils demonstrated the fact that it was beyond the capacity of the 18-32 H. P. Case tractor.

The same plough was used with a Sentinel steam tractor of 65 H. P., and even then its draught was considered heavy. It is much too heavy an implement for use in the small fields existing in the canal colonies of the Punjab, and it would probably take a tractor of the largest size manufactured by the Case Company to pull it. Its use is not recommended in the canal colonies of the Punjab as it is much too cumbersome for use in irrigated lands where the fields are small.

6. *A Ransomes "Orwell" 11-tined cultivator* was purchased in 1921. Since then it is the most commonly used tractor implement on the farm. The tines perform work similar to that done by a Desi plough and can be made to run deep or shallow as required. It has proved very useful in stirring up fallow lands and preparing seed-beds and can be strongly recommended for this purpose. It is rather light and the frame might be strengthened with advantage to the machine.

7. *A tandem disc-harrow with 32 discs*, manufactured by the International Harvester Co., was purchased in 1921. It has been used on the farm when occasion required but that was not often. Its main function is to pulverise hard, lumpy, dirty soils such as the stubble of sugarcane or some similar coarse-rooted crop. Outside work of this nature, it is not required in the canal colonies, as ordinary preparatory tillage can be much more economically and quickly done by means of a spring-tined harrow.

Its draught is very heavy and taxes all the tractors we have tried to their utmost capacity when the discs are adjusted at the maximum angles. It is a special purpose implement and is ordinarily not needed for cultivation in the Punjab.*

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* Elsewhere the implement has proved of use for the rapid preparation of land for *rabi* sowing.—*Ed.*

8. *Spring-tined harrow.* Four ordinary bullock spring-tined harrows were attached to a beam and pulled as a unit by the tractor. Such a combination makes a very satisfactory implement for stirring up fallow soils or preparing a seed-bed. It covers a width of 15 ft. at one time and thus gets over the ground rapidly. Its depth can be regulated as required from 2″ to 5″ according to the hardness of the soil. It is the harrow most commonly used by us, as it is less costly to operate than any of the other implements tried. Its use is strongly recommended; its size can be made to suit tractors of any power.

OBSERVATIONS ON THE ECONOMICS OF THRESHING.*

BY

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Brief History of Threshing Experiments conducted and reported so far.

One of the earliest papers on power threshing in India appeared in the *Agricultural Journal of India*, 1907, Vol. II. The author compared the cost of steam threshing with the country method of treading under bullocks. This comparison was made at Pusa and the power threshing set used was a Marshall's Thresher specially designed for use in India with a threshing drum 3 ft. wide. This was driven by a steam engine of 5 N. H. P. The machine was fitted with a *bhusa*-making attachment. The comparative cost by the two methods was worked out as follows :—

	Per md.	
	As.	P.
Threshing by steam engine and Marshall's Thresher	3	8
Threshing by first treading by bullocks and then winnowing by country method	5	6

The crop threshed in this case was oats. The *bhusa* produced was said to be "in every way equal to that given by treading". These figures indicate that threshing machinery of this type effected a considerable saving in the process. At that time, 22 years ago, threshing by modern methods in India was confined to a few planters' estates.

Six years later, Burt published the results of experiments conducted at Cawnpore with a steam threshing set. The machine used was a 30″ Ransomes N. I. L. Thresher fitted with a *bhusa*-making arrangement and driven by a portable steam engine of 3 N. H. P. The cost of threshing wheat worked out in this experiment at 5 as. 10 pics per maund on a basis of 60 days' work in the season. The cost of threshing *rabi* cereals by the country method was worked out at Rs. 1-4 per maund exclusive of winnowing which under favourable circumstances at that time was estimated to cost 1 to 2 annas per maund. In the same paper the cost of threshing in neighbouring villages was estimated at Re. 1 per maund. It was also found that with the Egyptian Norag Thresher, which then cost about Rs. 40, the cost of threshing was reduced to about 9 as. per maund including winnowing.

* Paper read at the 17th meeting of the Indian Science Congress, Allahabad, January 1930.

In 1915 a similar trial was made of steam threshers at Lyallpur by Roberts. The machines used were two Ransomes Threshers, a 30″ feed type and a 48″ feed type. The cost of threshing however has not been recorded in the paper. The machines appear to have worked very satisfactorily. The quality of *bhusa* produced by these machines is described as extremely good and the amount of grain damaged or cut was 2 to 5 per cent. The 30″ machine was driven by a 3 N. H. P. portable steam engine. The 48″ thresher was worked by a 8 H. P. Low Pressure steam engine.

At Cawnpore more recently, *i.e.*, in 1923 to 1926, Low experimented with two threshers of the same type, namely, a 30″ Ransomes N. I. L. Straw Chopping Thresher driven by a 4 H. P. steam engine and later in 1927 a new 30″ Ransomes Mosquito Straw Chopping Thresher driven by an 8 H. P portable steam engine. The cost of threshing per maund of grain worked out in both cases to 11 as. 3 pies. The old outfit was purchased in 1913 and the new one in 1926.

Details of recent experiment on threshing at Cawnpore.

In the *rabi* season 1928-29 a similar experiment was conducted by the writer on the Agricultural College Farm at Cawnpore with a 22″×38″ McCormic Deering Thresher fitted with a *bhusa*-making attachment and driven by a 15 to 30 H. P. kerosene oil International Motor Tractor. By way of comparison threshing was also done at the same time by the country method with bullocks. The details of the results obtained (Statements I and II) are interesting, as they throw light on the possibilities of reducing the cost of production of wheat for the market by the introduction of up-to-date power threshing machinery.

The cost of 7 as. 7 pies per maund obtained in this experiment (Statement I) is greater than the cost worked out by Burt in 1913 by 1 anna and 9 pies per maund of grain threshed and cleaned. But in the older experiment the calculations were based on a 60 days' working period, while the other is based on 20 days' work. Modifying the results of the present experiment down to 60 days' work in the year, the cost works out at 5 as. 2 pies per maund, showing considerable reduction.

The cost of threshing and winnowing by bullocks was worked out on the College Farm at Rs. 1-0-1½ per maund of grain. (Statement III.)

Tabulating all these results, we get an interesting comparison (Statement IV).

Compare with the above figures the cost of threshing of wheat in England in 1927. This at the rate of exchange that then prevailed works out at 7 as. per maund.

Possibilities attending the introduction of Modern Threshing Machinery driven by a Motor Tractor.

It appears from results obtained so far that an outlay of Rs. 9,000 on a threshing set like the McCormic Deering Thresher combined with a 15 to 30 H. P. motor tractor is justifiable if conditions favourable to its use exist. As a matter of fact

such conditions do exist in some parts of the irrigated tracts of the United Provinces. The fact that the threshing set is portable brings it within reach of agriculturists whose holdings adjoin each other over an area of, say, 1,000 acres. Suppose such a set is purchased co-operatively for a thousand acres of wheat land in one block. Assuming that 75 days are occupied in threshing at 150 mds. per day, an area of 1,000 acres would represent a yield of about 11,250 maunds of grain threshed. The threshing season extends from the beginning of April until the end of June and sometimes later. The cost of threshing and winnowing by the country method has been shown to be Rs. 1-0-1½ per maund and that by a threshing set working 60 days at 5 as. 2 pies per maund. The net gain to the producers of wheat in the area would thus be about 11 annas per maund amounting to about Rs. 7,734 for 1,000 acres, which is over 85 per cent. of the value of the threshing outfit in one single season. It should be noted that the cost of threshing per maund of wheat when the thresher works for 90 days, *i.e.*, the maximum for one season, will be even smaller than that worked out for 60 days' work in the season. The advantage of the motor tractor over the portable steam engine lies in the fact that it can be used with profit to cultivate the land when not required to work the thresher. Experiments on this problem are also being conducted at the Agricultural College Farm at Cawnpore.

Some additional Advantages of Modern Threshers over the Country Method of Threshing.

The following additional advantages of replacing the present methods of threshing by modern machinery are worthy of consideration :—

(1) The cultivators' bullocks are occupied in threshing from the beginning of April to the end of June. By the introduction of threshing machinery this bullock power is released and along with it a large amount of labour used in threshing and particularly in winnowing. (The threshing set for the amount of grain turned out uses a fraction of the labour required in the ordinary process.) This extra labour and bullocks can in irrigated tracts be usefully employed in preparing fields for early fodder crops. This keeps the soil safe from the undesirable effect of leaving the land uncultivated during the hot dry season, and enables the Kisan to cultivate his fields for an extra quantity of fodder either for sale or as feed for his cattle.

(2) After growing an early fodder crop on irrigated tracts, it is possible to follow up on the same field with a *rabi* crop because the early fodder crop is removed by August, leaving ample time for the preparation of the field for the *rabi* crop. This practice is actually being followed on the Agricultural College Farm at Cawnpore and has resulted in a very satisfactory per acre income.

(3) The release of bullock power also will enable the agriculturist to put down early cotton and even a crop of vegetables in the hot weather.

(4) The process of hand winnowing uses up a large amount of labour at a time when labour is scarce and dear owing to the existence of the marriage season.

(5) Experiments with various types of hand and bullock power threshers have shown—

(a) that the amount of power lost in transmission in small bullock power machines is abnormally high, and

(b) a single pair of village bullocks and even two pairs have been found quite incapable of continuously working the smallest machine tried.

(6) All the machines using bullock and hand power that have been tried have failed to make *bhusa.*

(7) *Bhusa* made by the latest types of threshers contains a small fraction of the quantity of dust always present in *bhusa* made by the country method.

CONCLUSION.

To summarise, experiments on modern threshing machinery since 1907 have shown that the cost of threshing wheat and other similar cereals is considerably less by improved machinery than by old methods.

(2) The actual gain to the Kisan in the cost of production of wheat by using modern threshing machinery is considerable.

(3) The use of such machinery releases a large amount of bullock and hand labour which can be profitably employed for preparing the land for the production of other crops such as early fodders and cotton.

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STATEMENT I.

Cost of running the McCormic Deering Threshing Set for 20 days.

	Rs.	A.	P.
Interest on capital (Thresher) at 6 per cent.	270	0	0
Interest on Tractor at 6 per cent. for 20 days out of a total of 60 days' work in the year, 40 days being charged to other work	90	0	0
Depreciation at 10 per cent. on Thresher	450	0	0
Depreciation at 10 per cent. on Tractor for 20 days on a basis of 60 days' work in the year	150	0	0
Repairs and renewals for Thresher	100	0	0
Repairs and renewals for Tractor Rs. 200, ⅓rd charged to threshing	66	10	8
Fuel 264 gallons of kerosene oil at Re. 0-12-8 per gallon	209	0	0
Petrol at 3 pints per day for 14 days' actual running at 3 annas per pint	7	14	0
Lubricating oil 1·66 gals. per day of 10 hours at 1·03 rupees per gallon	23	14	11
Grease 1·3 lb. per day at 2·6 lb. per rupee	7	0	0
Labour and staff	105	0	0
Miscellaneous	10	0	0
Total 20 days' cost	1,479	7	

This is equal to Rs. 73-15-6 per day.

The best outturn per hour obtained was 15·6 maunds, *i.e.*, 156 mds. per day of 10 hours. The cost of threshing per maund therefore 7 annas and 7 pies.

STATEMENT II.

Same machinery used as in Statement I but on a basis of 60 days' work.

	Rs.	A.	P.
Interest on capital (Thresher) at 6 per cent.	270	0	0
Interest on Tractor at 6 per cent.	270	0	0
Depreciation on Thresher at 10 per cent.	450	0	0
Depreciation on Tractor at 10 per cent.	450	0	0
Repairs and renewals for Thresher	300	0	0
" " " Tractor	200	0	0
Fuel 792 gallons of kerosene oil at Re. 0-12-8 per gallon	627	0	0
Petrol at 3 pints per day for 42 days' actual running at Re. 0-3-0 per pint	23	10	0
Lubricating oil 1·66 gallons per day of 10 hours at 1·03 rupees per gallon	71	12	9
Grease 1·3 lb. per day at 2·6 lb. per rupee	21	0	0
Labour and staff	315	0	0
Miscellaneous	30	0	0
Total cost for 60 days	3,028	6	9

This is equal to Rs. 50-7-7 per day or Rs. 50-7-7 ÷ 156 = Re. 0-5-2 per maund.

STATEMENT III.

Cost of threshing and winnowing by the country method at Cawnpore, 1928-29.

14 bullocks and 7 men employed at threshing turned out 20 mds. 4 seers of wheat grain ; extra men were required for winnowing in addition to this.

	Rs.	A.	P.
Cost of bullocks estimated at Rs. 2-2-0 per pair per day including interest on capital cost of bullocks and depreciation	14	14	0
14 men at Re. 0-6-0 per day	5	4	0
TOTAL .	20	2	0

i.e., Rs. 1-0-1½ per maund.

STATEMENT IV.

Abstract of results obtained by various methods from 1907 to 1929.

Year of experiment	By whom recorded	Type of machinery used	Cost per maund of grain threshed and winnowed. Rs.	A.	P.
1907 . .	Shearer .	Marshall's Thresher with a 3 ft. wide threshing drum driven by a steam engine of 5 N. H. P.	0	3	8
1907 . .	,, .	Threshing by treading by bullocks and winnowing by country method.	0	5	6
1913 . .	Burt .	30″ Ransomes Thresher driven by 3 N. H. P. portable steam engine.	0	5	10
1913 . .	,, .	Threshing by treading by bullocks and winnowing by country method.	1	5	6
1913 . .	,, .	Egyptian Norag Thresher	0	9	0
1923 . .	Low .	30″ Ransomes N. I. L. Straw Chopping Thresher driven by 4 H. P. steam engine.	0	11	3
1923 . .	,, .	30″ Ransomes Mosquito Straw Chopping Thresher driven by 8 H. P. portable steam engine.	0	11	3
1929 . .	Maya Das	22″×38″ McCormic Deering Thresher driven by a 15 to 30 H. P. kerosene oil International Motor Tractor.	0	5	2
1929 . .	,, .	Threshing by treading by bullocks and winnowing by country method.	1	0	1½

A NOTE ON THREE OIL-BEARING GRASSES FROM BURMA.

BY

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In parts of the dry zone of central Burma three scented species of *Cymbopogon* occur. At the suggestion of Mr. McKerral, Director of Agriculture, these grasses were examined to discover any economic value they might have.

1. *Cymbopogon clandestinus* Stapf.

This is the most abundant of the species to be described. It occurs in large quantities in dry rocky places, amongst open forest on hill sides, generally in association with *Anthistiria imberbis* Retz. var. *imberbis* Hack. It is a perennial, springing up during the rains, flowering about November and drying off about two months later when forest fires often burn it to the ground. Large quantities could be obtained for distillation if it was economic to do so. The Burmese name Myet-sat, meaning pungent-tasting grass, is an appropriate name.

The first samples were obtained from the foot-hills of the Shan plateau near Mandalay, in November 1927, when the grass was flowering. The only available still was a converted autoclave so that adequate quantities could not be dealt with. The yield of oil obtained from this small sample was 0·13 per cent. on dry matter.

In 1928, a large aluminium steam-heated still of the type used for citronella distillation was erected and in this about one ton of grass treated. The distillate was allowed to stand overnight when as much as possible of the supernatant oil was removed. The distillate was then returned to the still and redistilled, the oil being removed as before. If the second distillate seemed to warrant it, a third distillation was done. The oil did not separate readily from the water but formed an emulsion, rendering this procedure necessary. The final distillate was shaken with light petroleum to obtain the last of the oil. A yield of 0·26 per cent. of oil on dry matter was obtained, double of that obtained in 1927, possibly due to the grass being treated quickly while fresh instead of partly dried. The oil was a light straw colour with a pleasant smell somewhat resembling ginger-grass oil. An analysis carried out at the Imperial Institute[1] gave constants similar to oil previously tested at the Forest Research Institute from grass obtained from Mandalay and Maymyo in 1916.

[1] *Bulletin of the Imperial Institute*, Volume XXVII, No. 4, page 458, 1929,

The oil was submitted for valuation by the Imperial Institute and priced at from six shillings to seven shillings and six pence a pound. It was considered to be inferior in odour to a very good ginger-grass oil but about equal to an ordinary commercial sample. Presumably this valuation is c.i.f. London, and so does not hold out much prospect of a profitable export industry arising.

2. *Cymbopogon* nov. spec.

This annual grass, smaller than *C. clandestinus*, and differing chiefly in the glabrous pedicelled spikelets, is considered by the Director, Royal Botanic Gardens, Kew, to be an undescribed species. It is fairly abundant in parts of the dry zone. Generally cattle will not eat it because it is pungent, being known by the same Burmese name as the first, but in times of scarcity cattle eat it after drying and the writer has seen it offered for sale when better fodder was scarce at Rs. 1-12 per cartload.

In 1927, the late rains having been good, it was plentiful round Mahlaing and Tatkon, but only small quantities could be distilled. The green grass does not travel well, because it heats badly, the oil from such grass being much oxidised. In 1928 when large quantities could have been handled they were not obtainable, the late rains having been light. The grass flowers at about the same time as *C. clandestinus*. The pale straw-coloured oil tends to emulsify in the distillate and required similar treatment to *C. clandestinus*. The yield calculated on dry matter was 0·72 per cent. An analysis done at the Imperial Institute (*l.c.*) gave constants near those of *C. clandestinus* except for the optical rotation which is negative instead of positive and for the slightly higher specific gravity.

Though this oil could probably find a market as a substitute for ginger-grass oil, the grass is not abundant enough to justify its collection for distillation. The low yield and the fact that it is an annual giving only one cutting a year render it of little value from the oil-producing point of view. Its only value is as an inferior fodder when better is unobtainable.

3. *Cymbopogon virgatus* Stapf nov. spec.

This is a coarse perennial tufted grass growing in rocky places or amongst open forest. It is less common than the other two and so far as is known is not used as a fodder at any time. The Burmese names are Myet-sat and Naya-sat. The smell of the crushed leaves is distinctly unpleasant. The flowering stems grow to a height of about 8 feet, the flowering taking place in November. In a letter from the Director, Royal Botanic Gardens, Kew, it is stated that it is an undescribed species, and will be described in due course under the name *Cymbopogon virgatus* Stapf.

Only small quantities of this grass could be obtained. The oil separated more readily from the aqueous distillate, which was however redistilled once to obtain

the maximum possible yield, this being 0·55 per cent. on dry matter. An analysis kindly done by Messrs. Schimmel & Co. gave the following constants for this oil:—

Specific gravity (15°)	0·9556
Optical rotation (100 mm. tube)	—28° 53′
Refractive index (20°)	1·49107
Acid value	1·9
Ester value	6·5
Ester value after acetylation	72·8
Alcohol content calculated as $C_{10}H_{17}OH$	21·2%

The constants differ from those of the other two species chiefly in the low values for esters and alcohols.

The oil has a rather unpleasant smell and is considered to resemble Botha-grass oil. It is not likely to find a ready market even if it were abundant enough to make its collection and distillation on a commercial scale practicable.

SELECTED ARTICLES

THE WATER BALANCE OF PLANTS AS A FACTOR IN THEIR RESISTANCE TO INSECT PESTS.*

As a result of a review of the available evidence with regard to the effect of climatic and soil conditions on the distribution of the *Dysdercus* sp., the hypothesis was put forward by one of us (E. P. M.) in 1925-26 that a disturbed water content, from whatever cause, rendered the cotton plant more susceptible to the attack of sap-feeding insect pests, such as various species of thrips. Later it was found that this hypothesis appeared also to hold true in the case of certain sap-feeding insect pests of sugarcane, notably the froghopper *Tomaspis saccharina* Dist. So far as cotton is concerned, the hypothesis has since been confirmed by observations made in the field in California.

In the autumn of 1926 several extensive tours were made into the cotton-growing regions of California, which included not only the well-known Sacramento, San Joaquin, and Imperial Valleys, but also the lesser known Ferris, Coachella, Palo Verde, and Barde Valleys. At that time more than 160,000 acres of cotton were growing in California proper, an additional 130,000 acres occurring in Lower California. It was then found that thrips (*Heliothrips fasciatus* Perg.) attack on Acala cotton invariably followed faulty irrigation practice. Thrips were never found in large numbers on plants receiving an optimum water supply. It seemed that plants suffering from water shortage were definitely more attractive to the attacking thrips.

W. B. Camp, of the U. S. Bureau of Plant Industry, working in collaboration with the Department of Agriculture, has been carrying out a series of experiments on these lines for a number of years, and we have reason to believe that this hypothesis is supported and extended by the results of his researches. It also receives support from Bedford's observations on thrips (*Heliothrips indicus* Bagnall) attack on Egyptian cotton in the Sudan (*Wellcome Trop. Res. Lab., Khartoum, Ent. Sec. Bul.*, 18, 1921), though in some respects it would appear to be contradicted by Wardle's observations on *Thrips tabaci* Lind. attack on cotton in a Manchester greenhouse (*Ann. App. Biol.*, 14, 482 ; 1927. Compare also MacGill, *ibid.*, 16, 288 ; 1929).

With regard to the sugarcane froghopper (*Tomaspis saccharina* Dist.), the hypothesis has also received striking confirmation in practical experiments by

* Reprinted from *Nature*, Vol. 125, No. 3150, p. 411.

Withycombe (*Ann. App. Biol.*, 13, 64; 1926. *Proc. Agric. Soc. Trinidad and Tobago*, 26, No. 6, 294; 1926) and other workers in the West Indies. Increasingly we are led to believe that the hypothesis holds true for a large number, but not all, species of thrips, red spider, etc., as pests of a wide range of food plants. Several cases are cited by Lees (*Ann. App. Biol.*, 13, 506; 1926) in which heavy irrigation and heavy rainfall resulted in increased susceptibility to insect attack, but it is not improbable that, in a number of cases, conditions of physiological drought were present as a result of deficient soil aeration.

It seems also that the nitrogen content of the sap is an important factor with regard to susceptibility to attack. This has been referred to by Davidson (*Ann. App. Biol.*, 10, 35; 1923) and by Lees (*loc. cit.*). Experiments carried out by one of us (E. P. M.) on the curly-top disease of the sugar-beet in California, transmitted by the leathopper *Eutettix tenellus* Bak. (results to be published shortly in *Annals of Applied Biology*), point in a similar direction. There is, indeed, much evidence available which indicates that a highly nitrogenous diet stimulates reproduction. The two factors, water content and the nitrogen content of the sap, are interdependent, but it would form an interesting problem in nutrition to find which of the two is of the greater importance in any particular case.

The specific role of water in the metabolism of plant and insect is not mentioned by Uvarov in his recent memoir and review of the literature on insect nutrition and metabolism (*Trans. Ent. Soc., London*, Pt. 2; December 1928), although considerable attention is paid to the related subjects of the food of insects and the influence of diet on growth and reproduction. There is also no reference in "Filterable Viruses" (Ed. by T. M. Rivers; Bailliere, Tindall and Cox, 1929) to the water relationships in plants susceptible to virus diseases, but it is a frequent observation that plants so infected have, in general, poorly developed root systems.

In order to understand these diseases more fully, much further work will be necessary on insect nutrition and metabolism, their habits, host-plants, and rates of reproduction, and in particular on the specific biological relationships which appear to exist in many cases between the insect and the disease it transmits. In this connexion it seemed desirable again to direct attention to the water balance of plants as a factor in their resistance to insect pests.

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D. HOLROYDE HEY.

The University,
Manchester, Feb. 14.

OFFICIAL STANDARDS FOR AMERICAN RICE, II.

(Concluded from Vol. XXV, Pt. III.)

Standards for Brown Rice.

FOR the purposes of the United States standards for brown rice :—

Brown rice.—Brown rice shall be rice grown in continental United States from which the hulls only have been removed from not less than 90 per cent. of the kernels, and which does not contain more than 10 per cent. of cereal grains of a kind or kinds other than rice, seeds, or other foreign material, either singly or in any combination.

NOTE.—Brown rice for the purposes of the standards is divided into classes and sub-classes as follows : Class I, Honduras brown rice ; Class II, Edith brown rice ; Class III, Fortuna brown rice ; Class IV, Carolina brown rice ; Class V, Lady Wright brown rice ; Class VI, Blue Rose brown rice ; Class VII, Early Prolific brown rice ; Class VIII, Japan brown rice ; divided into sub-classes (*a*) Japan brown rice and (*b*) California-Japan brown rice ; and Mixed brown rice.

HONDURAS BROWN RICE (CLASS I).

This class shall include the rices known commercially as Honduras and Mortgage Lifter, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

EDITH BROWN RICE (CLASS II).

This class shall include the rice known commercially as Edith, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

FORTUNA BROWN RICE (CLASS III).

This class shall include the rice known commercially as Fortuna, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

CAROLINA BROWN RICE (CLASS IV).

This class shall include the rices known commercially as Carolina and Storm Proof, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

LADY WRIGHT BROWN RICE (CLASS V).

This class shall include the rice known commercially as Lady Wright, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

Grade requirements for the classes Honduras, Edith, Fortuna, Carolina, and Lady Wright brown rice.

United States grade	Maximum limits of										
	Cereal grains, seeds, mud lumps, and heat-damaged kernels (number in 500 grams)				Paddy grains	Red rice	Damage other than heat	Chalky kernels	Broken kernels		Other rices
	Cereal grains	Seeds	Heat-damaged kernels	Mud lumps					Total	Through No. 6½ sieve	
	No.	No.	No.	No.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Extra Fancy.	0	2	0	1	0·2	0·5	1	1·5	10	1	1
Fancy .	1	5	1	2	·4	1·0	3	2·5	15	2	2
Choice .	5	10	5	5	1·0	3·0	5	5·0	20	3	4

Sample grade :—Sample grade shall be brown rice of the class Honduras, Edith, Fortuna, Carolina, or Lady Wright, respectively, which does not come within the requirements for any of the grades from Extra Fancy to Choice, inclusive, or which has any commercially objectionable foreign odour, or is musty or sour, or is heating or hot, or is of a badly damaged or badly stained appearance, or is otherwise of distinctly low quality, or contains more than 0·1 per cent. of foreign material excepting paddy grains, other cereal grains, seeds, and mud lumps, or contains more than 14·5 per cent. of moisture.

Blue Rose Brown Rice (Class VI).

This class shall include the rices known commercially as Blue Rose, Greater Blue Rose, and Improved Blue Rose, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

Early Prolific Brown Rice (Class VII).

This class shall include the rice known commercially as Early Prolific, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

Japan Brown Rice (Class VIII).

This class shall include the rices known commercially as Japan and may include not more than 10 per cent. of whole kernels of rice of any other class or classes. This class shall be divided into two sub-classes designated as (*a*) Japan brown rice, and (*b*) California-Japan brown rice.

Sub-class (a) Japan brown rice.

This sub-class shall include all rices known commercially as Japan possessing the characteristics of rice of this class as grown east of the Rocky Mountains.

Grade requirements for classes Blue Rose and Early Prolific brown rice and the sub-class Japan brown rice.

United States grade	Maximum limits of										
	Cereal grains, seeds, mud lumps, and heat-damaged kernels (number in 500 grams)				Paddy grains	Red rice	Damage other than heat	Chalky kernels	Broken kernels		Other rices
	Cereal grains	Seeds	Heat-damaged kernels	Mud lumps					Total	Through No. 6¼ sieve	
	No.	No.	No.	No.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Extra Fancy.	0	2	0	1	0·2	0·5	1	1·5	5	1	1
Fancy .	1	5	1	2	0·4	1·0	3	2·5	10	2	2
Choice .	5	10	5	5	1·0	3·0	5	5·0	15	3	4

Sample grade:—Sample grade shall be brown rice of the class Blue Rose or Early Prolific or the sub-class Japan, respectively, which does not come within the requirements for any of the grades from Extra Fancy to Choice, inclusive, or which has any commercially objectionable foreign odour, or is musty or sour, or is heating or hot, or is of a badly damaged or badly stained appearance, or is otherwise of distinctly low quality, or contains more than 0·1 per cent. of foreign material excepting paddy grains, other cereal grains, seeds, and mud lumps, or contains more than 14·5 per cent. of moisture.

Sub-class (b) California-Japan brown rice.

This sub-class shall include all rices known commercially as Japan possessing the characteristics of rice of this class as grown west of the Great Plains area of the United States.

Grade requirements for the sub-class California-Japan brown rice.

United States grade	Maximum limits of										
	Cereal grains, seeds, mud lumps, and heat-damaged kernels (number in 500 grams)				Paddy grains	Red rice	Damage other than heat	Chalky kernels	Broken kernels		Other rices
	Cereal grains	Seeds	Heat-damaged kernels	Mud lumps					Total	Through No. 6¼ sieve	
	No.	No.	No.	No.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Fancy .	1	25	1	1	0·2	0·2	0·3	3	10	1	0·1
1.	3	50	3	3	·2	·4	·7	6	10	2	·2
2.	5	75	5	5	·4	·7	1·5	10	15	3	·2

Sample grade:—Sample grade shall be brown rice of the sub-class California-Japan brown rice which does not come within the requirements for any of the grades from Fancy to No. 2, inclusive, or which has any commercially objectionable foreign odour, or is musty or sour, or is heating or hot, or is of a badly damaged or badly stained appearance, or is otherwise of distinctly low quality, or contains more than 0·1 per cent. of foreign material excepting paddy grains, other cereal grains, seeds, and mud lumps, or contains more than 15 per cent. of moisture.

Grades for Mixed brown rice.

Mixed brown rice.—Mixed brown rice shall be a mixture of any two or more of Classes I, II, III, IV, V, VI, VII and VIII, which does not meet the requirements of any one of such classes.

Mixed brown rice shall be graded according to each of the grade requirements common to the class or sub-class of brown rice which predominates over each other class or sub-class in the mixture, except that all of the grade requirements in any class as to the maximum percentages of other rices shall be disregarded. The grade designation of mixed brown rice shall include, successively in the order named, the name of the grade or the number thereof, the word "mixed," and, in the order of its predominance, the name and approximate percentage of each class or sub-class of brown rice which constitutes 10 per cent. or more of the mixture, but if only one class or sub-class exceeds 10 per cent. of the mixture the name and approximate percentage of that class or sub-class shall be added to the grade designation, followed by the name and approximate percentage of at least one other class or sub-class.

Grades for Weevily brown rice.

Weevily brown rice.—Weevily brown rice shall be all brown rice which is infested with live weevils or other insects injurious to stored rice.

Weevily brown rice shall be graded and designated according to the grade requirements of the grade applicable to such rice if it were not weevily, and there shall be added to and made a part of such grade designation the word "Weevily".

Definitions.

Basis of determination.—All determinations shall be upon the basis of the lot of rice as a whole.

Percentages.—Percentages, except in the case of moisture, shall be percentages ascertained by weight.

Percentage of moisture.—Percentage of moisture shall be that ascertained by the moisture tester and the method of use thereof described in Bulletin 1375, dated February, 1926, issued by the United States Department of Agriculture Bureau of

Agricultural Economics, except that the flame shall be extinguished when the thermometer registers 200°C., or ascertained by any device and method giving equivalent results.

No. 6½ sieve.—A metal sieve perforated with round holes six-and-one-half sixty-fourths inch in diameter.

Damaged kernels.—Damaged kernels shall be kernels and pieces of kernels of brown rice which have been distinctly damaged by water, insects, or by any other means. Sound double and sound broken kernels shall not be considered damaged kernels.

Heat-damaged kernels.—Heat-damaged kernels shall be kernels and pieces of kernels of brown rice which have been distinctly discolored by external heat or as a result of heating caused by fermentation.

Cereal grains.—Cereal grains shall include barley, wheat, rye, emmer, spelt, einkorn, corn, grain sorghums, and oats, and shall not include buckwheat, flaxseed, and wild oats.

Seeds.—Seeds shall be grains, kernels or seeds, either whole or broken, of any plant other than rice or cereal grains.

Red rice.—Red rice shall be kernels or pieces of kernels of brown rice which are distinctly red in colour or have any appreciable amount of red bran thereon.

Broken kernels.—Broken kernels shall be split kernels of brown rice and pieces of kernels which are less than three-fourths of the length of the perfect kernels.

Chalky kernels.—Chalky kernels shall be kernels and pieces of kernels of brown rice one-half or more of which is chalky.

Mud lumps.—Mud lumps shall be lumps of dried mud which will not pass through a No. 6½ sieve. Mud lumps which will pass through a No. 6½ sieve shall function in grading only as foreign material.

Paddy grains.—Paddy grains shall be kernels of rice from which the hulls have not been removed.

United States Standards for Rough Rice.

For the purposes of the United States standards for rough rice :—

Rough rice.—Rough rice shall be rice grown in continental United States which contains not less than 50 per cent. of kernels of rice from which the hulls have not been removed, and which may contain not more than 50 per cent. of matter other than rice and not more than 10 per cent. of cereal grains of a kind or kinds other than rice.

HONDURAS ROUGH RICE (CLASS I).

This class shall include the rices known commercially as Honduras and Mortgage Lifter, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

Edith Rough Rice (Class II).

This class shall include the rice known commercially as Edith, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

Fortuna Rough Rice (Class III).

This class shall include the rice known commercially as Fortuna, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

Carolina Rough Rice (Class IV).

This class shall include the rices known commercially as Carolina and Storm Proof, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

Lady Wright Rough Rice (Class V).

This class shall include the rice known commercially as Lady Wright, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

Blue Rose Rough Rice (Class VI).

This class shall include the rices known commercially as Blue Rose, Greater Blue Rose, and Improved Blue Rose, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

Early Prolific Rough Rice (Class VII).

This class shall include the rice known commercially as Early Prolific, and may include not more than 10 per cent. of whole kernels of rice of any other class or classes.

Japan Rough Rice (Class VIII).

This class shall include the rices known commercially as Japan and may include not more than 10 per cent. of whole kernels of rice of any other class or classes. This class shall be divided into two sub-classes designated as (*a*) Japan rough rice, and (*b*) California-Japan rough rice.

Sub-class (a) Japan rough rice.

This sub-class shall include all rices known commercially as Japan possessing the characteristics of rice of this class as grown east of the Rocky Mountains.

Grade requirements for the classes Honduras, Edith, Fortuna, Carolina, Lady Wright, Blue Rose, and Early Prolific rough rice, and for the sub-class Japan rough rice.

MAXIMUM LIMITS OF

United States grade No.[1]	Damaged kernels		Red rice	Foreign material and finely broken kernels			Rice of other classes
					Inseparable		
	Total	Heat damage		Separable	Mud lumps	Cereal grains	
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent,	Per cent.	Per cent,
1.	2	0·0	0·5	2	0·0	0·0	1
2.	4	·1	3·0	4	·1	·1	2
3.	7	·2	6·0	7	·2	·2	4
4.	10	·3	10·0	10	·3	·3	6
5.	15	·4	20·0	15	·5	·5	10
6.	15	·5	30·0	15	1·0	1·0	10

[1] For special grade designations for weevily, damp, wet, seedy, very seedy, mud-dragged, stained, and musty rough rice see specifications given on pp. 340—342 inclusive.

Sample grade:—Sample grade shall be rough rice of the class Honduras, or Edith, or Fortuna, or Carolina, or Lady Wright, or Blue Rose, or Early Prolific, or the sub-class Japan, respectively, which does not come within the requirements for any of the grades from No. 1 to No. 6, inclusive, or which has any commercially objectionable foreign odour, or is sour, heating, or hot, or is otherwise of distinctly low quality. The rough rice in each grade above sample grade shall be cool.

Sub-class (b) California-Japan rough rice.

This sub-class shall include all rices known commercially as Japan possessing the characteristics of rice of this class as grown west of the Great Plains area of the United States.

Grade requirements for the sub-class California-Japan rough rice.

United States grade No.[1]	Maximum limits of						
	Damaged kernels		Red rice	Foreign material and finely broken kernels			Rice of other classes
				Separable	Inseparable		
	Total	Heat damage			Mud lumps	Cereal grains	
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cen.
1.	0·2	0·0	0·1	2	0·0	0·0	0·1
2.	·4	·1	·2	4	·1	·1	·2
3.	·7	·2	·5	7	·2	·2	·4
4.	1·0	·3	1·0	10	·3	·3	·6
5.	1·5	·4	2·0	15	·5	·5	1·0
6.	2·0	·5	5·0	20	1·0	1·0	1·0

[1] For special grade designations for weevily, damp, wet, seedy, very seedy, mud-dragged, stained, and musty rough rice see specifications given on pp. 340—342 inclusive.

Sample grade:—Sample grade shall be rough rice of the sub-class California-Japan which does not come within the requirements for any of the grades from No. 1 to No. 6, inclusive, or which has any commercially objectionable foreign odour, or is sour, heating, or hot, or is otherwise of distinctly low quality.

The rough rice in each grade above sample grade shall be cool.

Grades for Mixed Rough Rice.

Mixed rough rice.—Mixed rough rice shall be a mixture of any two or more of Classes I, II, III, IV, V, VI, VII and VIII which does not meet the requirements of any one of such classes.

Mixed rough rice shall be graded according to each of the grade requirements common to the class or sub-class of rough rice which predominates over each other class or sub-class in the mixture, except that all of the grade requirements in any class as to the maximum percentages of other rices shall be disregarded. The grade designation of mixed rough rice shall include, successively, in the order named, the number of the grade, the word "mixed," and, in the order of its predominance, the name and approximate percentage of each class or sub-class of rough rice which

constitutes 10 per cent. or more of the mixture; but if only one class or sub-class exceeds 10 per cent. of the mixture the name and approximate percentage of that class or sub-class shall be added to the grade designation, followed by the name and approximate percentage of at least one other class or sub-class.

Grades for Damp and Wet Rough Rice.

Damp rough rice.

In the case of rice other than of the sub-class California-Japan rough rice all rough rice containing more than 14 per cent. but not more than 15·5 per cent. of moisture shall be considered damp.

In the case of rice of the sub-class California-Japan rough rice all rough rice containing more than 15 per cent. but not more than 16 per cent. of moisture shall be considered damp.

Damp rough rice shall be graded and designated according to the grade requirements of the grade applicable to such rice if it were not damp, and there shall be added to and made a part of such grade designation the word " Damp ".

Wet rough rice.

In the case of rice other than of the sub-class California-Japan rough rice all rough rice containing more than 15·5 per cent. but not more than 17 per cent. of moisture shall be considered wet.

In the case of rice of the sub-class California-Japan rough rice all rough rice containing more than 16 per cent. but not more than 17 per cent. of moisture shall be considered wet.

Wet rough rice shall be graded and designated according to the grade requirements of the grade applicable to such rice if it were not wet, and there shall be added to and made a part of such grade designation the word " Wet ".

Note.—All rough rice containing more than 17 per cent. of moisture shall be considered of low quality and shall be graded " sample grade."

Grades for Seedy and Very Seedy Rough Rice.

The determination of whether rough rice is seedy, very seedy, or sample grade on account of seeds shall be made after the removal of separable foreign material.

Seedy rough rice.

If, after the removal of separable foreign material, in the case of rice other than of the sub-class California rough rice, rough rice contains more than 0·1 per cent. but not more than 0·5 per cent of weed seeds it shall be considered seedy.

If, after the removal of separable foreign material, in the case of rice of the sub-class California-Japan rough rice, rough rice contains more than 0·5 per cent. but not more than 1·5 per cent. of weed seeds it shall be considered seedy.

Seedy rough rice shall be graded and designated according to the grade requirements of the grade applicable to such rice if it were not seedy, and there shall be added to and made a part of such grade designation the word " Seedy ".

Very Seedy rough rice.

If, after the removal of separable foreign material, in the case of rice other than of the sub-class California-Japan rough rice, rough rice contains more than 0·5 per cent. but not more than 1 per cent. of weed seeds it shall be considered very seedy.

If, after the removal of separable foreign material, in the case of rice of the sub-class California-Japan rough rice, rough rice contains more than 1·5 per cent. but not more than 3 per cent. of weed seeds it shall be considered very seedy.

Very seedy rough rice shall be graded and designated according to the grade requirements of the grade applicable to such rice if it were not very seedy, and there shall be added to and made a part of such grade designation the words " Very Seedy ".

NOTE.—If, after the removal of separable foreign material in the case of rice other than of the sub-class California-Japan rough rice, rough rice contains more than 1 per cent. of weed seeds it shall be considered of low quality and shall be graded " Sample grade." If, after the removal of separable foreign material in the case of rice of the sub-class California-Japan rough rice, rough rice contains more than 3 per cent. of weed seeds it shall be considered of low quality and shall be graded " Sample grade."

GRADES FOR WEEVILY ROUGH RICE.

Weevily rough rice.—Weevily rough rice shall be all rough rice which is infested with live weevils or other insects injurious to stored rice.

Weevily rough rice shall be graded and designated according to the grade requirements of the grade applicable to such rice if it were not weevily, and there shall be added to and made a part of such grade designation the word " Weevily ".

GRADES FOR STAINED, MUD-DRAGGED, AND MUSTY ROUGH RICE.

Stained rough rice.

Stained rough rice shall be rough rice which has been distinctly discolored by climatic conditions or in any other manner.

Stained rough rice shall be graded and designated according to the grade requirements of the grade applicable to such rice if it were not stained, and there shall be added to and made a part of such grade designation the word " Stained ".

Mud-dragged rough rice.

Mud-dragged rough rice shall be rough rice in which there are more than 2 per cent. of kernels with a distinct amount of mud clinging to them.

Mud-dragged rough rice shall be graded and designated according to the grade requirements of the grade applicable to such rice if it were not mud-dragged, and there shall be added to and made a part of such grade designation the word " Mud-dragged ".

Musty rough rice.

Musty rough rice shall be rough rice which has an unmistakable musty odour.

Musty rough rice shall be graded and designated according to the grade requirements of the grade applicable to such rice if it were not musty, and there shall be added to and made a part of such grade designation the word " Musty ".

MILLING QUALITY.

Milling quality shall be based on the value of the rough rice for milling purposes. The test for milling quality shall be determined by use of the Smith shelling device, described in mimeograph circular USGSA-GI, No. 34, dated August, 1925, issued by the Bureau of Agricultural Economics, United States Department of Agriculture, or as determined by any device or method giving equivalent results.

Milling quality shall be determined as prime milling quality, good milling quality, medium milling quality, fair milling quality, ordinary milling quality, or low milling quality. The milling quality so determined and stated shall be added to the grade designation.

DEFINITIONS.

Basis of determinations.—Each determination of general appearance, temperature, odour, moisture, separable foreign material and finely broken kernels, milling quality, mud-dragged and insects injurious to stored rice shall be on the basis of the lot of rice as a whole. Each determination of red rice, damaged kernels, and other classes shall be upon the basis of the rice after shelling. All other determinations shall be upon the basis of the rice when free from separable foreign material and finely broken kernels and before shelling.

Percentages.—Percentages, except in the case of moisture, shall be percentages ascertained by weight.

Percentage of moisture.—Percentage of moisture shall be that ascertained by the moisture tester and the method of use thereof described in Bulletin No. 1375, dated February, 1926, issued by the United States Department of Agriculture, Bureau of Agricultural Economics, except that the flame shall be extinguished when the thermometer registers 200°C., or ascertained by any device and method giving equivalent results.

Damaged kernels.—Damaged kernels shall be kernels and pieces of kernels of rough rice which have been distinctly damaged by water, insects, or by any other means. Sound broken kernels and kernels of which the hulls only have been damaged shall not be considered as damaged kernels.

Heat-damaged kernels.—Heat-damaged kernels shall be kernels and pieces of kernels of rough rice which have been distinctly discolored by external heat or as a result of heating caused by fermentation.

Separable foreign material and finely broken kernels.—Separable foreign material and finely broken kernels shall be all matter other than rice which will not pass through a No. 12 sieve and all kernels and pieces of kernels of rough rice and all foreign matter which will pass through a No. 6½ sieve.

No. 12 sieve.—A metal sieve perforated with round holes twelve sixty-fourths inch in diameter.

No. 6½ sieve.—A metal sieve perforated with round holes six-and-one-half sixty-fourths inch in diameter.

Mud lumps.—Mud lumps shall be lumps of dried mud which will pass through a No. 12 sieve but which will not pass through a No. 6½ sieve. Mud lumps which will not pass through a No. 12 sieve or which will pass through a No. 6½ sieve shall function in grading only as " separable foreign material and finely broken kernels ".

Cereal grains.—Cereal grains shall include barley, rye, wheat, emmer, spelt, einkorn, corn, grain sorghums, and oats, and shall not include buckwheat, flaxseed, and wild oats. Cereal grains which will not pass through a No. 12 sieve or which will pass through a No. 6½ sieve shall function in grading only as " separable foreign material and finely broken kernels ".

Weed seeds.—Weed seeds shall be grains, kernels, or seeds, either whole or broken, of any plant other than rice or other cereal grains. Weed seeds which will not pass through a No. 12 sieve or which will pass through a No. 6½ sieve shall function in grading only as " separable foreign material and finely broken kernels ".

Red rice.—Red rice shall be whole or broken kernels of rice of which the bran is distinctly red or pink in colour.

NOTES

AGRARIAN REFORM IN LATVIA.

THE *International Review of Agriculture* (Part II, monthly bulletin of agricultural economics and sociology) for November 1929 contains the concluding portion of an exceedingly interesting article on agrarian reform in Latvia. The extent of the social reconstruction which has taken place can be gauged from the fact that, under the pre-war system of large estates, two-thirds of the rural population were landless labourers most of whom have now become peasant farmers. Up to January 1928 no less than 127,410 new farming units had been created, through the subdivision of large estates and the allocation of State lands. The average size of the new holdings is about 15 hectares and two-thirds are from 15 to 22 hectares. The average area of " former " holdings rented is 35 hectares. One-third of the new holdings are below 15 hectares, these being mainly near towns.

Of special interest is the part which co-operative societies and agricultural associations have played in this reform which has been accompanied by a steady intensification of agriculture and the development of agricultural industrial enterprises. [B. C. B.].

MANURING OF PADDY IN LOWER BURMA.

Owing to the proof copy of the article on " Manuring of Paddy in Lower Burma " which appeared in the March (1930) issue (Vol. XXV, Pt. II) being delayed in the post, it was published without the corrections of the author who wishes to add the following note :—

> Since the experiments quoted in this paper were carried out, and since this paper was written in May 1929, there have been considerable changes in the prices of both paddy and fertilizers in Burma. Fertilizers have become very much cheaper and their prices in relation to each other have changed. The margin of profit from their use however remains about the same in spite of the fall in the price of paddy. The data collected regarding the actual and percentage increases in yield obtainable by using fertilizers are not affected by price considerations and should be of permanent interest and value. This also applies to the data concerning effective N : P_2O_5 ratios and the relative efficiency of the different forms of fertilizer used.
>
> There appears to be a tendency towards still further price modifications in a downward direction, and the recent introduction into India of two

grades of another ammonium phosphate fertilizer called 'Nicifos' at an even lower price than before, marks a new and welcome addition to the list of post-war fertilizers suitable for this country.

SUGAR REFINED FROM *GUR* IN INDIA IN 1928-29.

Of the 33 concerns in India equipped for the refining of *gur* or raw sugar, 19 are sugar factories which also manufacture sugar direct from cane and 14 are equipped for refining only. Of the former, only four refined *gur* during the season 1928-29 (the others working sugarcane only); of the 14 refineries which work with *gur* alone, 10 worked during the year and four were silent. There were thus 14 factories refining *gur* as compared to 19 working in 1927-28.

The figures of *gur* or raw sugar melted, sugar made, and molasses obtained in the whole of India during the season 1928-29 are given below. The figures for the concerns in the United Provinces, Bihar and Orissa, and Madras and the Punjab are also given separately for the information of those interested.

Total for the United Provinces.

	1928-29 Maunds	1927-28 Maunds
Gur or raw sugar melted	7,30,260	16,96,644
Sugar made	3,62,848	8,00,879
Molasses obtained	2,91,857	7,14,135

Total for Bihar and Orissa.

Gur or raw sugar melted	1,60,125	3,00,452
Sugar made	73,705	1,51,294
Molasses obtained	68,281	1,17,150

Total for Madras and the Punjab.

Gur or raw sugar melted	7,01,225	7,64,816
Sugar made	4,08,292	4,64,753
Molasses obtained	2,17,561	2,29,028

Grand Total for India.

Gur or raw sugar melted	15,91,610	27,61,912
Sugar made	8,44,845	14,16,926
Molasses obtained	5,77,699	10,60,313

A note published in the January (1930) Number of this Journal (Vol. XXV, Pt. I) gives the total quantity of sugar produced by factories making sugar direct from cane for the two seasons 1928-29 and 1927-28 as follows :—

1928-29	18,52,322 maunds or 68,050 tons.
1927-28	18,45,752 maunds or 67,808 tons.

If the quantity of sugar refined from *gur* or raw sugar in India by modern processes during these seasons be added to the above figures, the total production will amount to 26,97,167 maunds or 99,088 tons as compared with 32,62,678 maunds or 119,863 tons.

A table is given below showing the production of sugar direct from cane and from refining *gur* or raw sugar during the last ten seasons :—

Production of Sugar.

Year	Direct from cane	Refined from *gur*	TOTAL
	Maunds	Maunds	Maunds
1919-20	6,28,920	12,11,274	18,40,194
1920-21	6,69,291	13,24,645	19,93,937
1921-22	7,53,638	13,03,433	20,57,071
1922-23	6,51,415	13,68,126	20,19,541
1923-24	10,44,856	15,38,304	25,83,160
1924-25	9,21,950	9,16,121	18,38,071
1925-26	14,45,061	10,47,420	24,92,481
1926-27	17,16,426	15,91,997	33,08,423
1927-28	18,45,752	14,16,926	32,62,678
1928-29	18,52,322	8,44,845	26,97,167

Another table is given below showing the number of factories that produced sugar direct from cane as well as the number of those that refined *gur* or raw sugar in India during the last five years :—

Year	No. of factories that produced sugar direct from cane	No. of factories that refined *gur* or raw sugar
1924-25	23	13
1925-26	23	19
1926-27	25	22
1927-28	26	19
1928-29	24	14

It will be seen that the quantity of sugar refined from *gur* or raw sugar in 1928-29 shows a marked decrease, making the total sugar production lower than in the preceding season. The number of factories working with *gur* or raw sugar has also decreased.

In conclusion, the writer wishes to express his obligations to the Managing Agents, Proprietors and Managers of the various concerns for kindly furnishing the figures worked up in this note. [HARDAYAL SINGH.]

BOARD OF ECONOMIC INQUIRY, PUNJAB.

At a meeting of the Rural Section of the Board of Economic Inquiry, Punjab, held in April last, four publications were reported to be in the press. One of them deals with the milk supply of Lyallpur, another is the 1928-29 instalment of Mr. H. R. Stewart's interesting series entitled "Farm Accounts in the Punjab", while the remaining two relate to Jullundar and Rohtak Districts. Economic inquiries in Rawalpindi, Lyallpur and Gujranwalla Districts have been completed and reports relating to them will be published shortly. Among the eight reports either in circulation among the members of the Board or with the Secretary, special mention may be made of one dealing with food consumption in Khanewal; the remaining seven reports relate to the Multan, Gurgaon, Jhelum, Ambala, Sialkote, Hissar and Montgomery Districts. Inquiries into the weights and measures current in the Kangra and Ferozepore Districts have also been completed, while that into the economic conditions of gut makers in and around Sialkote appears to call for further investigation.

The general economic conditions in Ferozepore, the financing of the wheat crop in Lyallpur and Ferozepore and the milk supply of Lahore form the subjects of new inquiries started during the current year. It is also proposed to start a general economic inquiry in a village selected for the purpose in the Muzaffargarh District as soon as a suitable investigator is found.

INDIAN SUNN-HEMP.

INDIAN sunn-hemp now has a chance that may never occur again to establish itself firmly on the British market, according to the latest publication of the Empire Marketing Board ("Indian Sunn or Sann Hemp: Memorandum prepared by the Imperial Institute." E. M. B. 25, H. M. Stationery Office, London, 1*s.* net.)

Recently Indian sunn-hemp, which is employed in Great Britain for the manufacture of ropes, cables, twines, nets, etc., has begun to be used on a larger scale as a substitute for Russian hemp, which is difficult to obtain owing to the great decrease in production and export since the War. The value of sunn-hemp fibre exported from India last year was 83 lakhs.

"Sunn-hemp", says the Report, "may now perhaps secure for itself a sound position as against Russian hemp, a chance which it never had before and may never have again. Once established in the market, it would be very difficult to dislodge."

The memorandum outlines the methods of cultivation, preparation, characteristics of the fibre, marketing, and export trade of the plant, which is a member of the pea and bean family. It is particularly valuable not only on account of the fibre, but because it is used as a cover and a green manure crop. Like most legumes, it has the power of fixing nitrogen from the atmosphere, and therefore enriches the soil at the same time as producing a crop. Pulling or cutting may be delayed (without injury to the fibre) until the seeding stage, by which time the leaves have dropped to the ground and formed a layer of valuable organic manure.

It is also used as a smother crop to control weeds, and in a rotation before such crops as sugarcane, tobacco, potato, jute, etc.

A Peasant Industry.

The production of sunn-hemp in India is essentially a peasant industry. The chief areas concerned in its cultivation are Madras, the United Provinces, Bombay and Sind, and the Central Provinces and Berar. The yield of fibre ranges from 200 to 1,200 lb. per acre, with an average of 500—800 lb.

The report considers that the home market could absorb more sunn-hemp from India, but that reform in cultivation and marketing methods is necessary before it can command better prices. At present the hemp fetches less—and sometimes considerably less—than Italian, Russian and Hungarian hemps. "This is due," states the report, "to faults which could in large measure be corrected, and not to the fibre being intrinsically so much inferior to true hemp as the difference in price might suggest."

Retting, for instance, is sometimes carried out so unscientifically that the quality of the fibre is damaged. Retting in mud or muddy water, as is done in some districts, results in so much dust and dirt in the product that factory workers in some countries decline to spin it. Make-up of bales and pressure vary considerably, different grades are mixed, and sometimes adulteration takes place.

These and other factors result in a product of unreliable quality, and this adversely affects the market price. "The attention of the Indian authorities has been directed on various occasions to these defects," concludes the report, "and considerable effort has been made to remedy them through the Agricultural Departments.

"There is an opportunity for India to set its house in order and produce, from all or most of the hemp-growing districts, a fibre up to the commercial standard at present reached by few.

"From the manufacturers' point of view there is already available in the better grades of sunn-hemp a fibre which can take the place of the diminishing supply of Russian hemp. It is hoped that this publication may be of assistance in leading to an increased production of this Empire fibre and to its more extended utilisation."

COTTON NOTES.

THE following abstracts have been received for publication from the Secretary, Indian Central Cotton Committee :—

REPORT OF THE COMMISSION OF ENQUIRY INTO THE COTTON INDUSTRY, 1929.

(Printed by the Government Printer, Entebbe, Uganda ; price shs. 3/50.)

This report has recently appeared. The Commission was composed of the following members : Sir William Morris Carter (Chairman), the Hon. A. D. Jones (Member of the Legislative Council), and Mr. P. W. Adshead (Chief Accountant, Public Works Department). The terms of reference were :—

(*a*) To frame estimates of the reasonable cost of purchase of seed cotton (exclusive of price paid), of transport to ginneries, of ginning and baling such cotton, and of transporting it to the railway, indicating as closely as possible the items comprised in these costs and the separate amounts thereof.

(*b*) Having regard to such estimates and other necessary factors, including the ruling price of Uganda cotton in the world's markets and the current price obtainable for cotton seed, to lay down a formula for ascertaining from time to time whether a fair price is being paid to native cultivators in Uganda for seed cotton.

And to investigate into and report :—

(i) Whether in accordance with that formula the prices paid to native cultivators of cotton in Uganda during each of the years 1927, 1928 and 1929 were fair and reasonable.

(ii) Whether, and to what extent, the formation of Cotton Buying Associations has had a prejudicial or beneficial effect on the price paid to native cultivators, and on the cotton industry generally.

(iii) Whether, and in what manner, the Government could or should intervene in an endeavour to ensure that fair prices are received by native producers of cotton.

The report commences with a brief history of the cotton industry in Uganda since its inception in 1903. Cotton was bought and collected mainly by Indian traders, who stored it in their shops. Open markets succeeded this system of trading, and these in turn were replaced by permanent centres, with permanent buildings, such as exist at the present day. A cotton tax of 4 cents per pound of lint, imposed in 1919, has now been placed on a sliding scale according to the price of American Middling, Liverpool. After the war the building of ginneries proceeded rapidly, and while in 1914 there were only 20, there were 176 working in 1926. Associations of ginners for buying purposes are now coming into operation.

The estimates called for in (*a*) of the terms of reference are given in considerable detail in Appendix 3, and a summary of the costs is also included. Costs vary in different parts of the Protectorate, and separate figures are therefore given for Buganda, Eastern Province, and Northern Province ; the Commission is of opinion,

however, that the time available for an exhaustive examination of costs was far too short.

It is shown in the Appendix that the greatest differences in price occur in buying expenses, costs of labour, transport hauls, and railway freight.

In reference to section (*b*) of the terms of reference, the Commission considers that it is both possible and practical to lay down a formula of cost to ascertain from time to time whether a fair price is being paid to the native cultivator in Uganda for seed cotton. The formula recommended is as follows :—

$$X \left\{ \begin{array}{l} \text{the price payable to grower in cents} \\ \quad \text{per lb. of seed cotton.} \\ \end{array} \right\} = \frac{3}{10}\,(A + P - C)\,;$$

where A is the price of American futures four months ahead to allow time for the cotton to arrive on the Liverpool market ; P an approximate figure to represent the probable premium payable for Uganda cotton on that date ; C a figure to represent the cost of buying, transport, ginning, etc., and overhead expenses (as represented in the Table of Costs). 30 per cent. of the figure thus arrived at would then represent a fair price payable to the native cultivator per pound of seed cotton. The Commission explained that the assessment of the probable premium payable for any grade of Uganda cotton over American Middling four months in advance presents a great difficulty, and could only be given by experts actively engaged in the Liverpool cotton market. It considers, however, that the Government could make satisfactory arrangements to receive periodical advices in this respect from members of the Liverpool Cotton Association.

The adjustment of costs for each area mentioned in the table of costs is then dealt with under the heads of profit, savings effected by co-operative buying, increase or decrease of output, and cotton seed.

In regard to section (*i*) of the terms of reference, the actual prices paid to growers as compared with those deduced from the formula are given for the last three years, and the opinion is expressed that the prices paid during this period were generally fair and reasonable, with the possible exception in 1927 of those paid in the Bukedi, Teso and Lango areas, and in 1928 in Buganda and the Bukedi area.

In regard to section (*ii*), the Commission considers that the formation of cotton buying associations has not greatly affected prices except in Buganda, but it has affected the prices received by individual growers, and has thus bewildered the natives. The formation of these associations has, however, undoubtedly reduced the buying costs and curtailed the operations of middlemen.

In considering the present condition of the cotton industry, the Commission points out that Uganda is over-ginneried, and that 50 per cent. of the present ginneries would suffice. It is stated that the ginners must combine for self-preservation, that the number of ginneries should be reduced, and that the capacity of those remaining should be enlarged in order to deal with the greater output, and that groups of ginneries, each under one management to save managerial and overhead expenses, should come into being.

In view of the above circumstances, the Commission recommends, in regard to section (*iii*) of the terms of reference, that the Government, while not taking any drastic steps at the moment, should define its attitude and indicate its future lines of action. It is also recommended that legislation should prohibit increase in the present ginning capacity except as approved by Government, a Board being appointed to deal with the question, and that Government be authorized to act in the best interests of the natives if no association has been formed among the ginners by September 1, 1931.

Associations in certain respects should be controlled by Government, and when four-fifths of the ginners in the Eastern and Western areas have joined, the remainder should be compelled to come in or lose their licenses. The terms of Government control are considered, and recommendations made for the prevention of cheating and sharp practices.

In discussing the question of improvement in and increase of cotton cultivation in Uganda, the Commission recommends the appointment of additional officers to the staff, more demonstrations of modern methods of cultivation by the use of implements, etc., given to the natives; instruction in schools; more attention paid to rotation of crops and information on all cotton matters given to native chiefs, and efforts made to bring about closer and more cordial relations between grower and ginner, in order that they may realize their dependence on one another.

The report contains several long appendices dealing with costs, assessment of compensation, and miscellaneous matters.

LE COTONNIER, VOL. I—Ray C. P. Boone. (Soc. d'Editions Geographiques, Maritimes et Coloniales, 184, Boulevard Saint-Germain, Paris, 1929.)

There is an interesting preface by Professor de Wildeman, calling attention to some of the most important points in the book. He gives a quotation from Professor Lecomte, stating that production is extending towards the East.

This first volume is largely devoted to the thorny question of specific grouping, more especially of the cultivated forms, in *Gossypium*. The author accepts the common division into *G. barbadense*, *hirsutum*, *herbaceum*, *indicum*, *neglectum*, *arboreum*, *religiosum*, etc. He calls attention to the many conditions that have to be fulfilled to make cotton a success in any given place, and to the advantages of one-locality—one-variety, co-operation amongst planters, and of breeding local varieties for local conditions. Heredity, hybridization, and selection are dealt with, and also the biology of the cotton plant. The volume ends with an extensive bibliography. The whole work, when complete, should prove of great value to many who are conducting enquiry into cotton questions.

COTTON PLANT: RATOONING IN MOROCCO—E. Miege. (*Int. Rev. Agr.*, 19, 1929. Abstr. from *J. of Text. Inst.*, xx, 5, 1929, A. 231.)

Ratooning of the cotton plant should be done before vegetation recommences, with a different technique according to the countries considered. In Algeria

ratooning is practised for three years, and during variable periods in New California, the Sudan, and Senegal. The disadvantages of the operation are the production of refuse and multiplication of pests. For the latter reason ratooning has been forbidden in Egypt and in certain of the States of America. However, owing to the early seasonal ripening induced by the method, the ratooned plantations of North Africa are not more liable to attack than annual plantations. The refuse may vary from 2 to 5 per cent. or more (especially in Haute-Volta), but this is solely due to faulty technique and to local conditions. The refuse is considerable if the soil is cold. The advantages are quicker ripening (four to six weeks), and the need of less water, the ratooned cotton plant requiring two irrigations less. The yields are increased, but generally the quality is not good. In this respect, however, Algeria and Morocco are exceptions.

[Extracts from *Empire Cotton Growing Review*, VI, No. 4.]

THE FUSARIUM DISEASE OF COTTON (WILT) AND ITS CONTROL—T. Fahmy. (*Egypt Min. Agr., Tech. and Sci. Serv. Bul.* 74 (1928), pp. VII+106, pls. 48.)

An account is detailed of the *Fusarium* disease of cotton, which has been shown to cause much loss to cotton interests, particularly in the Nile Delta where Sakel is the prevailing variety. The external and internal symptoms are given. The fungus, which persists in the soil and which may infect cotton more or less severely as influenced by various factors, produces under artificial conditions a toxin causing cotton seedling wilt. The relations between host and parasite are outlined, with an account of the isolation, morphology, and cultural characters of the causal fungus (*F. vasinfectum*). For this, in its local form, the author suggests the varietal designation *F. vasinfectum egyptiacum*, as it disagrees in certain characters with the form causing the wilt disease in India and America.

Methods of control are discussed. Bare fallow is useless. Soil disinfection with carbon disulfide proves expensive and impracticable. Different cotton varieties were tested as to susceptibility. From the susceptible Domains Sakel four resistant strains have been separated. These have been grown in heavily infected soil during two consecutive years and have yielded a product graded as Sakel of good quality. The method for future propagation is given. [*U. S. Department of Agriculture Experiment Station Record*, Vol. 61.]

COTTON ROOT ROT AND FUSARIUM WILT: RELATION TO ACIDITY AND ALKALINITY OF THE SOIL—J. J. Taubenhaus, W. N. Ezekiel, and D. T. Killough. (*Rev. Appl. Mycol.*, 1929, 8, 308; from *Texas Agric. Exper. Sta. Bull.*, 389, 1928, 19 pp.)

When *Phymatotrichum omnivorum* was cultivated on artificial media the maximum growth occurred at pH 7; growth was inhibited at pH 4·1 and 8·9. An extensive field survey of the cotton-growing areas of Texas showed that root rot due to this fungus was present in 34 per cent. of the fields having soil with a pH value of 5·5 to 6·4, in 60 per cent. of those where the pH value was 6·5 to 7·4, and in 71 per cent. of those where it ranged from 7·5 to 9. On the acid soils root rot seldom

reached significant proportions. Wilt (*Fusarium vasinfectum*), on the other hand, occurred in 55 per cent. of the fields with acid soils, in 13 per cent. of those with nearly neutral soils, and in only 2 per cent. of those with alkaline soils. Root rot was found in 42 per cent. of the fields with a soil basicity (determined by treating 10 gm. soil with 100 c.c. of 0·2 N nitric acid and titrating with 0·1 N sodium hydroxide, the results being expressed as percentage basicity of calcium carbonate) of 0 to 0·9 per cent. in 80 per cent. of those with a soil basicity of 1 to 2·5 per cent. and in 81 per cent. of those where it ranged from 2·5 to 10 per cent. *F. vasinfectum* was present in 32 per cent. of the first group, 8 per cent. of the second group, and was absent from the third group. The existence in Egypt of a strain of *F. vasinfectum* which attacks cotton on alkaline soils also is considered to be a potential danger to American cotton.

COTTON ROOT ROT DISEASE : INOCULATION—J. J. Taubenhaus, B. F. Dana, W. N. Ezekiel, W. J. Bach, and J. P. Lusk. (*Rev. Appl. Mycol.*, 1929, 8, 502 ; from *Phytopath*, 1929, 19, 167—170.)

An outline is given of a method evolved by the writers for the inoculation of cotton and other plants with the causal organism of root rot (*Phymatotrichum omnivorum*). Recently wilted cotton or other plants are pulled by hand, the tops cut off at ground level, and the roots (usually covered with a copious surface growth of the fungus) dropped into moist sacks, kept moist, and used as rapidly as possible for inoculum. Under field conditions a crowbar is used to pierce a hole in the soil 1 to 1½ inches from the stem of the plant to be inoculated. One or more of the fresh pieces of inoculum are placed in the hole, 1 or 2 inches below the surface, and the soil pressed together again. Particularly successful results have been obtained in soils with a high moisture content. Out of 840 cotton plants at College Station, Texas, inoculated by this method in the early summer of 1928, 346 wilted within the next 24 days. Of 52 cotton plants inoculated with naturally infected carrot roots, 26 succumbed to the disease in six weeks. In both these lots almost every plant was killed by root rot within the following three weeks, while there was still under 1 per cent. of the disease in the adjacent control rows. Similar results were obtained in inoculations on a smaller scale for greenhouse or plot work. Successful cross-inoculations were made by this method from cotton and various other hosts to a large number of cultivated crop plants and fruit trees, a list of which is given [Extracts from *British Cotton Industry Research Association—Summary of Current Literature*, Vol. IX, No. 20.]

COTTON FLOWERS : NATURAL CROSSING IN EGYPT—W. L. Balls. (*Min. Agri. Egypt, 1929, Bull.* 89, 27 pp.)

• A report is given of a study of the cause of the natural crossing of cotton flowers in Egypt and its distribution in time and space. Experimental data and distribution curves are given, together with field observations and a list of insects responsible for natural crossing in cotton. Gauze of 64 meshes to the square inch is amply fine

enough to arrest the pollen-carrying agents. The facts disclosed by the investigation are of sufficient magnitude to account for all the known phenomena of varietal deterioration.

New Cotton Wilt—J. J. Taubenhaus, W. N. Ezekiel, and H. E. Rea. (*Rev. Appl. Mycol.*, 1929, 8, 501—502 ; from *Phytopath*, 1929, 19, 171—173.)

A severe wilt disease of cotton, apparently distinct from that caused by *Fusarium vasinfectum*, has been reported from three widely separated counties of Texas, especially from Ellis County. Affected plants are stunted and peculiarly branched with abnormally short, stout joints ; in advanced stages of the disease the plants shed their leaves and the branches become dull in colour. In some cases the plants die from the tops and new growth appears on the lower part of the main stem. Only a few of the diseased individuals are able to produce one or two bolls of cotton. Occasionally the dwarfing and stunting of infected plants is so marked as to give the impression of a rosette. The new disease may be differentiated from *Fusarium* wilt by the splitting of the stems and by black discoloration of the interior cylinder of both roots and stems ; in the typical *F. vasinfectum* wilt the latter phenomenon is mostly confined to the outer woody tissue. In the new disease the discoloration is more pronounced in the lower part of the plant, becoming progressively less higher on the stem. Isolations from the Ellis County plants yielded a *Fusarium* apparently distinct from *F. vasinfectum*, besides species of *Alternaria, Sclerotinia, Phoma, Phomopsis*, and *Helminthosporium*. The occurrence of the new wilt in the heavy black lands where root rot (*Phymatotrichum omnivorum*) is destructive is considered to be specially significant. It has recently been shown that *Fusarium* wilt is mostly confined to soils more acid than pH 6·5—7·0 while root rot is destructive under more alkaline conditions. In other words, this is the first occasion on which the two types of disease, root rot and wilt, have been found in a severe form on the same soils. According to Fahmy, there is a certain type of wilt occurring in Upper Egypt on the Ashmouni and Zagoro cotton varieties which is characterised by an apparently harmless discoloration of the central cylinder of the root, hypocotyl, or lower part of the stem. The *Fusarium* isolated from the discoloured regions failed to infect the varieties in question and the fungus is accordingly considered non-parasitic. This type of wilt appears to be very similar to that observed in Texas, except that in the latter region the discoloration is associated with a serious disease of the plants.

Pink Bollworm : Control in Egypt—N. W. Barritt. (*Rev. Appl. Entomol.* 1929, 17, 503 ; from *Bull. Entomol. Res.*, 1929, 20, 41—43.)

The author points out that although the Government has enforced vigorous measures for the control of the pink bollworm (including the compulsory ginning of all seed cotton before May and heat treatment of all seed cotton) throughout Egypt since 1919, no significant change in the extent of attack is shown in the figures given by Williams of the seasonal variation of this pest from 1916 to 1924. These figures show that the attack begins with about 5 per cent. infestation at the

beginning of July, increases to 15 per cent. in the first week of August and then rapidly rises to 60 or 70 per cent. in the first week of September, after which every boll is attacked. It seems probable that this is due to the natural rate of increase of the insect when an abundant supply of bolls is available and that the occurrence of only a few moths in each locality in June is sufficient to produce 100 per cent. attack in September. Thus, although 98 per cent. of the hibernating larvae may be killed by the control measures, larvae or pupae in fallen bolls buried in the soil or in bolls on cotton sticks stored for fuel are quite sufficient to start the outbreak in July. Unfortunately it has not been found practicable to destroy these bolls, and the adoption of some control measures during July and August therefore seemed desirable. Experiments were carried out with a castor oil-resin emulsion used as a deterrent to oviposition. The results were inconclusive, but suggest the feasibility of control along these lines and the possibility of employing a protective belt of sprayed plants in fields that have not recently carried a cotton crop and in which buried bolls are not a source of infestation.

PINK BOLLWORM: MIGRATION—J. A. Todd. (*M/cr. Guard. Comm.*, 1929, 19, 475.)

Sporadic outbreaks of the pink bollworm have caused anxiety for several years in Texas. These outbreaks seem to be more of the nature of a new infestation than of the continued presence of the pest carried over from year to year. The prime source of infestation is probably in the Laguna Valley in Mexico where pink bollworm is always present in considerable numbers throughout the whole season. A study of the habits of the moth in Mexico showed that about the beginning of September large numbers are carried up involuntarily by strong convection currents to a maximum of about 3,000 feet. There they meet a "contra-trade" wind which carries them northward till, somewhere north of the United States boundary, they meet contrary winds which cause them to fall to the ground in large numbers, many of them alive. These movements of the moths have been traced by means of traps carried on aeroplanes from Mexico across 200 miles of desert to the nearest outlying points of the cotton belt, which lie in the Big Bend district of the Rio Grande, thence to the isolated irrigated districts in the Pecos Valley, and thence to the western fringes of the main cotton belt in Texas.

GINNING: EFFECTS ON QUALITY. (*M/cr. Guard. Comm.*, 1929, 19, 425.)

The United States Bureau of Agricultural Economics is carrying out an investigation of ginning and the quality of cotton. The relative efficiencies and effects of different mechanical processes of cleaning on the spinning qualities of the ginned lint, the variation of these efficiencies and effects with different machines in various combinations and operations, the nature and extent to which the character of the fibres, the moisture content, and the proportion of foreign matter influence the relative effects of the cleaning and ginning processes and the variation of the relations for different types of gins and different methods of operation are being studied.

[*Extracts from British Cotton Industry Research Association—Summary of Current Literature*, Vol. IX, No. 21.]

COTTON PLANT: GENETICS—S. C. HARLAND. (*Trop. Agric.*, 1930, 7, 16–18.)

The results of studies of the inheritance of petal spot, flower colour, and pollen colour in inter-specific and also in intra-specific crosses are discussed. Unexpectedly complex results were obtained, but the results of varietal crosses helped to explain those of the more intractable into specific crosses. It is concluded that pollen colour, spot and corolla colour are determined by a simple factor pair in both varietal and inter-specific crosses. In varietal crosses there is segregation of the main gene alone, whereas in the inter-specific cross there is segregation of modifiers which may partially, or in some cases entirely, obscure the distinction between dominant and recessive. Hence the problem of breeding for desirable combinations of economic characters resolves itself almost entirely into the manipulation of modifying factors. The difficulty of combining Upland corolla colour with the petal spot and pollen colour of Sea Island is illustrated. The mode of inheritance of certain leaf and seed characters in crosses between different varieties of Upland cotton is discussed. [*British Cotton Industry Research Association—Summary of Current Literature, by Dr. J. C. Withers*, Vol. X, No. 4.]

WOODHOUSE MEMORIAL PRIZE.

In memory of Mr. E. J. Woodhouse, Late Economic Botanist and Principal of Sabour Agricultural College who was killed in action in France in 1917, a prize in the form of a silver medal and books of a combined value of Rs. 85 will be awarded to the writer of the best essay on a subject of botanical interest to be selected from the list below. The length of the essay should not exceed 4,000 words.

The competition is open to graduates of Indian Universities and to Diploma holders and Licentiates of recognised Agricultural Colleges in India who are not more than 30 years of age on the date of submission of their essays.

Papers should be forwarded to the Director of Agriculture, Bihar and Orissa, Patna before December 1st, 1930.

Failing papers of sufficient merit no award will be made.

G. S. HENDERSON,
Director of Agriculture, Bihar and Orissa.

List of subjects for 1930 prize :—

1. Breeding of disease resistant crops.
2. The importance of Statistical study in modern Agriculture.
3. Intermittent bearing of the mango trees—its cause and cure.
4. Biometrical studies in relation to heredity and variation.
5. The value of mutations in the improvement of crops by Plant breeding methods.
6. Soil flora and its relation to crop plants.

Personal Notes, Appointments and Transfers, Meetings and Conferences, etc.

Mr. Albert Howard, C.I.E., Director of the Institute of Plant Industry, Indore, and Agricultural Adviser to States in Central India and Rajputana, has been awarded the Barclay Memorial Medal by the Asiatic Society of Bengal. The medal is awarded each alternate year to that person, who, in the opinion of the Council, has made the most important contributions to Medical or Biological Science with special reference to India.

Mrs. G. L. C. Howard, M.A., Second Imperial Economic Botanist, Pusa, on deputation to the Institute of Plant Industry, Indore, has been granted leave on half average pay for three months and one day with effect from 30th January, 1930.

Mr. B. S. Patel, N.D.D., N.D.A., C.D.A.D., Deputy Director of Agriculture, Gujarat, has been granted leave on average pay for four months with effect from 1st May, 1930.

Mr. C. S. Patel, B.Ag., Cotton Superintendent, Surat, has been appointed to act as Deputy Director of Agriculture, Gujarat, *vice* Mr. B. S. Patel granted leave.

Mr. Baburao Shankarrao Kadam has been appointed Crop Botanist to Government, Bombay, and placed on probation for a period of two years.

Mr. M. Carbery, M.C., M.A., B.Sc., Agricultural Chemist to the Government of Bengal, has been granted leave on average pay for six months with effect from 23rd April, 1930.

Mr. A. P. Cliff, B.A., Deputy Director of Agriculture, North Bihar Range, has been granted leave on average pay for eight months with effect from 9th April, 1930.

MR. BENI MADHAB CHATTERJEE, B.A., M.Sc. (Agri.), Assistant Director of Agriculture, Bihar and Orissa, has been appointed to hold charge of the North Bihar Range, during the absence, on leave, of MR. A. P. CLIFF.

BABU BHUT NATH SARKAR, L.Ag., Assistant Director of Agriculture, Bihar and Orissa, has been appointed to hold charge of the Chota Nagpur Range, during the absence, on leave, of MR. C. A. MACLEAN.

The appointment of SARDAR SANTOK SINGH, B.A., B.Sc., N.D.D., to a special temporary post in the Civil Veterinary Department, Punjab, has been extended by a further period of one year with effect from 16th January, 1930, pending the constitution of the Superior Provincial Veterinary Service.

MR. A. MCKERRAL, M.A., B.Sc., Director of Agriculture, Burma, has been granted combined leave for nine months with effect from 1st May, 1930.

MR. T. D. STOCK, D.I.C., A.R.C.S., B.Sc., Deputy Director of Agriculture, has been appointed to officiate as Director of Agriculture, Burma, *vice* MR. A. MCKERRAL proceeding on leave.

U PE THAN, Officiating Deputy Director, Veterinary Services, has been appointed to the Burma Veterinary Service (Class 1) with effect from 1st April, 1930.

MADRAS AGRICULTURAL SERVICE.

The following G. O. No. 501, dated 10th March, 1930, has been issued by the Government of Madras :—

The Royal Commission on Superior Services recommended that no further recruitment should be made to the Indian Agricultural Service and that the personnel required therefor should in future be recruited and appointed by Local Governments. In accordance with the above recommendation recruitment to the Indian Agricultural Service was stopped in 1924 and vacancies in that service were filled up by the creation of temporary posts in the Madras Agricultural Service pending the creation of the new Provincial Service.

2. The Royal Commission on Agriculture which examined the question recommended that the Provincial Agricultural Service might be constituted into two

classes—Class I replacing the Indian Agricultural Service and Class II the existing Provincial Service with the corresponding scales of pay. The chances of recruitment of non-Asiatics to Provincial Services are small and future recruits will ordinarily be from local men. The demand of Indians in the past for high salaries was based on the claim that they should get the same salary as the majority of the service. Now that the Provincial Service will recruit few non-Asiatics, the scale of pay should be fixed so as to be suitable for the fields from which recruitment is to be mainly made. The Government have given this question their most careful consideration and have come to the following decisions :—

(1) The present members of the Indian Agricultural Service will continue with no change in their conditions of service.

(2) Where there is a permanent or temporary vacancy in the Indian Agricultural Service the post will be abolished or kept in abeyance, as the case may be, and a corresponding post created in the Madras Agricultural Service.

(3) The new Provincial Service will consist of only one class on Rupees 250—25—550—25—750 with 10 per cent. of the cadre being in the selection grade on Rs. 800—25—1,000; during the transition stage when the new Provincial Service and the existing All-India Service will exist side by side the number of appointments in the Indian Agricultural Service excluding that of the Director of Agriculture will count against these 10 per cent. selection grade posts.

(4) The Principal of the Agricultural College when he is a member of the Provincial Service will be given a special pay of Rs. 100 in addition to grade pay.

(5) The pay of the Director of Agriculture when held by a member of the Madras Agricultural Service will be Rs. 1,250—50—1,500.

On the above basis, the six vacant posts of Government Entomologist, Government Agricultural Chemist, Government Lecturing Chemist, Government Systematic Botanist and two Deputy Directors of Agriculture in the Indian Agricultural Service, which have been held in abeyance, will be abolished, and the existing six temporary posts in the Madras Agricultural Service created in their stead will be added permanently to the cadre of the Madras Agricultural Service. The two posts of Agrostologist and Deputy Director, Northern Cotton tract, in the Indian Agricultural Service, which have been till now kept unfilled, will be abolished, no new posts being created in the Madras Agricultural Service in their place. The post of Paddy Specialist in the Indian Agricultural Service will be abolished when the contract of the officer at present holding the post expires and a corresponding post in the Madras Agricultural Service will be permanently added then to the Provincial cadre. The special post of Headquarters Deputy Director which is now filled by an Indian Agricultural Service officer will continue as a special post so long as an Indian Agricultural Service

officer is available for it, after which it will be merged in the cadre of the Madras Agricultural Service. The existing temporary posts of Agricultural Research Engineer, Superintendent, Cattle Farm, Hosur, and Oil-seeds Specialist will continue as such during the period of their present sanction.

3. The two posts of Assistant Agricultural Engineer and Lecturer in Engineering, Agricultural College, in the scale of Rs. 250—20—750, which are now borne on the cadre of the Madras Agricultural Service, will be transferred to the cadre of the Madras Engineering Service.

4. This sanction has been registered as No. 268 of 1929-30.

5. A copy of these proceedings will be forwarded to the Government of India for their information.

REVIEW

We have received the first (January 1930) number of the **Journal of the Trichinopoly District Agricultural Association**. It is divided into two sections—one in English, dealing with subjects of a technical nature, and one in Tamil which is more popular in character. The following are the principal contents of the January number :—

English Section.

1. District Agricultural Associations and their work.
2. How Big Estates can benefit themselves and the poor Ryots by co-operating with the Agricultural Department.
3. The Trichinopoly District Agricultural Conference and the Exhibition.
4. The rules of the Trichinopoly District Agricultural Association.
5. The Vital Importance of Organic Manure.

Tamil Section.

1. Agricultural Improvements and Co-operative Agricultural Associations.
2. Co-operation in Agriculture.
3. The rules of the Trichinopoly District Agricultural Association.

The Journal, which for the present will be issued every quarter, is intended for free distribution to the members of the Association. The annual subscription for non-members has been fixed at Rs. 1-8-0.

NEW BOOKS

On Agriculture and Allied Subjects

1. Statistical Methods for Research Workers, by R. A. Fisher. Third edition, revised and enlarged. Pp. XIV+283. (London and Edinburgh: Oliver and Boyd.) Price, 15*s*. net.
2. Heredity in Live Stock, by Christian Wriedt. Pp. XI+179. (London: Macmillan and Co., Ltd.) Price, 7*s*. 6*d*. net.
3. Fleming's Veterinary Obstetrics: including the Diseases and Accidents incidental to Pregnancy and Parturition. Fourth edition, revised by J. F. Craig. Pp. 552. (London: Baillière, Tindall and Cox.) Price, 18*s*. net.
4. The Improvement of Yield in *Hevea Brasiliensis*, by F. Summers. Pp. VII+198. (London, Singapore, Shanghai and Hongkong: Kelly and Walsh, Ltd.) Price, 12*s*. 6*d*.
5. The Maintenance of Soil Fertility, by C. E. Thorne. Pp. 332. (New York: Orange Judd Publishing Co., Inc.: London: Kegan Paul and Co.) Price, 18*s*. net.

The following publications have been issued by the Imperial Department of Agriculture in India since our last issue:—

Memoir.

1. Studies in Gujarat Tobaccos and their Improvement, Part I, by Vallavdas M. Majmudar, B.Ag. (Botanical Series, Vol. XVIII, No. 4.) Price, As. 12 or 1*s*. 3*d*.

Bulletins.

2. The Production of Oranges in Spain, by W. Robertson Brown. (Pusa Bulletin No. 198.) Price, As. 6 or 6*d*.
3. List of Publications on the Botany of Indian Crops (Compiled by F. J. F. Shaw, D.Sc., A.R.C.S., F.L.S., and Rakhal Das Bose, B.Sc., F.L.S.) (Pusa Bulletin No. 202.) Price, Rs. 3-8-0 or 6*s*.
4. The Description of a new Fluke found in the House Crow (*Corvus splendens*), by V. R. Phadke, G.B.V.C., and Amar Nath Gulati, M.Sc. (Pusa Bulletin No. 203.) Price, As. 3 or 4*d*.
5. A Method of increasing the Manurial Value of Bone Phosphate, by N. D. Vyas, L.Ag. (Pusa Bulletin No. 204.) Price, As. 8 or 10*d*.

MGIPC—M—III-1-32—6-11-30—2,000

PLATE XXIX.

The Late MRS. ALBERT HOWARD.

ORIGINAL ARTICLES

THE LATE MRS. ALBERT HOWARD.

At Geneva, on August 18th, 1930, death brought to a premature end a notable comradeship in life and work which for 25 years has done much to advance the application of science to crop-production.

Before her marriage in 1905, Miss G. L. C. Matthaei spent 10 years at Newnham College where, after taking a first class in both parts of the Natural Science Tripos, she came under the influence of the late Miss Ida Freund from whom she learnt one invaluable lesson—the power of making details her servant and at the same time allowing master ideas to rule. From Dr. F. F. Blackman, F.R.S., she gained equally useful experience in the founding of new principles on the results of careful, thorough and patient experimentation. Her papers on vegetable assimilation were published in the Philosophical Transactions of the Royal Society of London, and have since become classic. Before leaving Newnham she was elected to a Fellowship and later on was chosen as an Associate of the College.

In 1905, Miss Matthaei married Mr. Albert Howard, Imperial Economic Botanist to the Government of India, and then began that unique partnership, first at Pusa and later at Indore, which has lasted till the present year. The results are to be found in 128 papers and books which have appeared during the last twenty years. Many of the earlier papers deal with plant-breeding questions, including the creation and distribution to the cultivators of India of the well-known Pusa wheats which now cover over 3,000,000 acres and which bring in yearly an addition to the wealth of India of at least three million sterling. Many of the later papers deal with the best methods of applying science to crop-production, a subject which eventually led to the foundation of the Institute of Plant Industry at Indore, already widely recognized as a milestone in the development of agricultural science. In the heavy and detailed work involved in the foundation and development of the new Institute, Mrs. Howard's great powers of organization found the fullest scope. Her scientific insight and wide knowledge of agriculture also assisted greatly in framing the programme of research work and in obtaining practical results. On the human side, her strong personality, which was combined with great charm of manner and intense devotion to India, enabled her successfully to collaborate with the whole staff of the Institute.

Her work in India rapidly attracted attention and also official recognition. In 1910, she was made Personal Assistant to her husband : in 1913 she was appointed Second Imperial Economic Botanist to the Government of India and was also

awarded the Kaiser-i-Hind medal of the first class by H. M. the King. She took a deep and practical interest in the genesis and development of the Indian Science Congress, and presided over the Botanical and Agricultural Sections of this gathering. Had she lived, she would very probably have been elected President of the whole Congress.

Besides her official duties and the care and attention she devoted to her beautiful home at Indore, Mrs. Howard retained to the end a large circle of friends both in India, in Great Britain and in Germany.

TRACTOR TRIALS AT LYALLPUR, PUNJAB.*

BY

D. P. JOHNSTON, A.R.C.Sc.I., N.D.A., I.A.S.,

Assistant Director of Agriculture, Punjab.

In the year 1920 the Punjab Agricultural Department purchased two motor tractors (here designated " A " and " B "), each of 12-20 H.P. The former " A " was of the ordinary wheeled type, whilst the latter " B " was of the caterpillar type. The costs of working and capabilities of each of these machines were thoroughly studied over a period of years at the Lyallpur Experimental Farm. They were used for ploughing and cultivation, also for all kinds of stationary work, such as driving threshers, fodder-cutters, cane-crushing mills, pumps, etc. Neither was found very reliable, as they were continually developing mechanical defects of various kinds, particularly in the engine. Their chief drawback was that they had not got sufficient power to pull a three-furrow plough in the Lyallpur soils, which are similar to the ordinary alluvial soils usually found in the Indo-Gangetic plain. They " ran-hot " for the greater part of the year, with the radiator water at, or near, boiling point—even during the cold season. Excessive wear and tear resulted from this continued overheating and other causes, and both tractors wore out very rapidly ; so much so, that they were lying under repairs in the workshop most of their time.

A complete record of the time worked, the nature of the work done and the supplies of oil, spares, etc., consumed was kept. This information is summarised in the statement on page 470. When Tractor " A " had completed 510 hours' work, the cost of spare parts purchased worked out at Rs. 2-1-6 per running hour. At this stage it was discarded as uneconomical for cultivation work and thereafter used only for demonstration purposes.

Tractor " B " was even worse, the caterpillar tracks proving troublesome, due to the rapid wear thereof. After 687 hours the cost of spare parts worked out at Rs. 5-12 per running hour, so it was discarded except for occasional demonstrations.

* *See also* " Tractor Cultivation at Lyallpur, Punjab." *Agri. Jour. India*, Vol. XVIII, Part I.

Of the two types, the caterpillar is more suitable for cultivation purposes, as it is very easily manipulated and can readily turn in its own length. Its chain tracks give it a better grip and enable it to pull a much greater load in soft soils than the wheeled type. The position of the belt pulley on the forward end of the crank-shaft renders it unsuitable for stationary work, chiefly due to the difficulty of fixing and keeping the belt in alignment with the machine being driven.

As a result of our experience with the afore-mentioned machines it was considered that higher powered tractors were necessary; consequently in 1925 an 18-32 H. P. tractor——" C "—and a steam tractor of 65 H. P.—" D "—were purchased. The latter was obtained because it was thought that a steam engine might prove more reliable and less troublesome than an internal combustion engine.

Motor tractor " C " proved itself more reliable and economical than either " A " or " B." When it had done 1,133 hours' work the cost of spare parts averaged Rs. 1-13 per running hour. Its effective economic life at least for cultivation purposes is now about finished, so it is being relegated to the museum. Its record and costs of working are given in the statement at page 470.

Tractor " D " was a steam machine of unusual design, and so requires a little description. It had caterpillar driving tracks behind and a pair of ordinary steering wheels in front. The boiler was placed forward and the propelling mechanism in rear. The steam pressure was very difficult to maintain, and was never satisfactory even after many changes had been made in the boiler fittings by a mechanic sent by the agents to put it right. The steering was also very unsatisfactory, the response to the steering wheel being very erratic and uncertain, with the result that it was impossible to plough a straight furrow or turn the machine on a headland of less than 10 to 15 yards. The difficulty of obtaining a suitable water-supply and the time required to refuel and water it was almost equivalent to the time spent in actual working. It was found impossible to do satisfactory work with it, and it proved more costly in operation than any of the other tractors tried, so it was discarded and returned to the makers in 1929.

In 1928 a 15-30 H. P. motor tractor designated " E " was offered to us free for trial. This machine has now done 934 hours' work with an expenditure of Rs. 0-0-8 per running hour on spare parts. It has recently been opened up in order to see the condition of the engine which was found satisfactory in every way, no excessive wear being apparent. This tractor is easy to operate and has proved itself more reliable and more economical than any tractor hitherto tried by us. Its effective life will probably be two or three times that of tractor " C ". The costs of working are given in the statement on page 470.

In 1929 another tractor of 14-28 H. P. designated " F " was supplied to us free for trial. It had not got sufficient power to pull a three-furrow plough 5" deep on low gear and always " ran-hot ". The general design was as antiquated as that of the first tractor tried by us ten years earlier. After a few months' trial it was returned to the agents as it was quite unsuitable for Punjab conditions.

Possibilities for Tractor cultivation in the Punjab.

When tractors were first introduced into the Province large landlords thought that with the aid of such machines they might be able to dispense with tenants, or at least reduce labour costs on such lands as they had under direct cultivation. A little experience, however, disillusioned them as they discovered that, ordinarily speaking, tractors were neither as reliable nor as economical as bullocks, and that their use was limited by existing conditions.

In 1929 the Agricultural Department made a census of tractors and tractor-owners in the Province. The numbers, as far as could be ascertained, were as follows :—

Tractors	40
Tractor-owners	29

The experiences of these, particularly the early owners, were somewhat similar to our own; they lost faith in them, and tractor cultivation suffered a serious set-back in consequence. As time went on, however, manufacturers continued to improve designs, so that there are now many very reliable machines on the market, but the most important factor connected with their economic operation, *i.e.*, " depreciation ", is still too heavy.

With regard to the actual use of tractors as a motive force in agriculture, it was early recognized that they could not entirely replace animal power in general farming here, and that they were mainly special purpose machines.

They are, however, considered invaluable for certain purposes, *viz.*—

(*a*) For the initial breaking up of hard lands.
(*b*) For preliminary cultivation on large estates where labour is scarce.
(*c*) As a stand-by on large estates of 300 acres and upwards for augmenting the animal power in busy seasons.
(*d*) Driving portable machinery, such as threshers, ensilage-cutters, pumps, etc.

Early experience with tractors was so unsatisfactory that most landowners are now rather inclined to fight shy of them, and confidence will again have to be restored before cultivators will take them up.

Most of the tractors now on the market are fairly reliable, just as much so as is the modern motor car. The main consideration in connection with them now is to test their capabilities under actual working conditions and to find out their wearing capacity. This we are endeavouring to do at Lyallpur. The data collected up-to-date has been summarised in the statement appended.

In conclusion, the writer desires to record his thanks to L. Nathu Ram, Farm Manager, Lyallpur, for the consistent interest he has shown throughout these prolonged trials and for maintaining the records.

Statement showing particulars regarding the working of the various tractors tried at Lyallpur.

Name of tractor	No. of hours work done	No. of over-hauls given	Average rate of working per hour with a three-furrow plough	Average cost of fuel and lubricant per acre for ploughing	Total of cost of ploughing per acre *	Cost of spares per running hour	REMARKS
			Acres	Rs. A. P.	Rs. A. P.	Rs. A. P.	
A. 12-20 H. P. .	510	8	0·50	4 0 0	10 0 0	2 1 6	Almost worn out, only used for demonstration purposes.
B. 12-20 H. P. .	687	16	0·82	3 12 0	9 8 0	5 12 0	Do.
C. 18-32 H. P. .	1,133	18	0·99	2 6 5	6 1 5	1 13 0	Worn out.
D. 65 H. P. . .	400	4	0·57	5 5 3	15 1 0	1 8 0	Returned to manufacturer.
E. 15-30 H. P. .	934	1	1·0	2 1 9	3 15 9	0 0 8	Returned to the supplying firm, after trial, in working order.
F. 14-28 H. P. .	111	..	0·66	3 15 1	5 15 7	..	Found unsatisfactory and returned to the supplying firm in working order.

* This includes interest on capital @ 7 per cent., depreciation @ 20 per cent., cost of repairs and spares, labour, fuel and lubricants and also upkeep of implements.

SOME INVESTIGATIONS INTO THE EFFECT OF FERTILIZERS ON THE GROWTH AND OIL-CONTENT OF A VARIETY OF LINSEED (*LINUM USITATISSIMUM* L.).*

BY

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Some observations regarding the effect of certain artificial fertilizers on the height of plants, number of basal branches and yield of seed of two types of linseed were made at Pusa by G. L. C. Howard and A. Rahman Khan [1] in the years 1921 to 1923. Their investigations showed that the addition of 30 per cent. organic matter in the form of leaf-mould produced an increase of approximately 30 per cent. in the height, 100 per cent. in the number of basal branches and 250 per cent. in the yield of seed per 100 plants. Of the inorganic fertilizers they tried sodium nitrate at the rate of 4 cwt. per acre. This also caused a small increase in the height and number of basal branches and also a considerable increase in the yield of seed. It yet remained to be seen how far other inorganic fertilizers (*i.e.*, phosphatic and potassic manures) would affect these and other characters in linseed. The present investigation was therefore undertaken mainly with the view of comparing the effect of some different inorganic fertilizers, and the results obtained are reported in this article.

It may be mentioned, however, that the results given are based on the observations made during one year of the author's post-graduate training in the Botanical Section at Pusa, and that, although the data obtained may not be considered sufficient to be conclusive, certain important features of interest have been noticed during these preliminary investigations, and it is believed that a brief account of these will prove of value to those engaged in similar research.

The experiment was carried out in a dozen lysimeters which were filled with the same kind of soil in as uniform a manner as possible. The lysimeters are so constructed and arranged as to act admirably as small experimental plots having an area of one thousandth of an acre each. The following plan shows the relative

* These investigations were carried out, by the author at Pusa in the year 1928-29, when he was undergoing a special course of training in the Botanical Section of the Imperial Agricultural Research Institute, Pusa.

[1] Howard, G. L. C., and Khan, A. Rahman. Studies in Indian Oil-seeds. 2. Linseed. *Mem. Dept. Agri. India, Bot. Ser.*, XII, No. 4, January 1924.

position of the 12 plots (lysimeters) with the name and the rate of fertilizer per acre as applied in each case.

1 Control	4 Superphosphate @ 2 md. per acre	7 Sodium nitrate @ 1 md. per acre	10 Complete manure
2 Sodium nitrate @ 1 md. per acre	5 Control	8 Potassium sulphate @ 2 md. per acre	11 Control
3 Potassium sulphate @ 2 md. per acre	6 Complete manure	9 Control	12 Superphosphate @ 2 md. per acre

Each of the fertilizers was added to the soil in its respective plot just before sowing, by sprinkling it on the surface and mixing it with the upper layer of soil. The amount of the fertilizer used being small, it was in each case mixed with a small amount of earth and then uniformly broadcasted over the previously prepared and thoroughly levelled soil-beds before putting in the seeds on 16th November, 1928.

The seed sown in each plot belonged to the same type of linseed, *viz.*, T. 124, harvested at Pusa last year. This type was not described by G. L. C. Howard and A. Rahman Khan among the 123 types mentioned by them in their Memoir above referred to, as it was found later, in 1925, when it appeared in the Botanical Area in cultures of Type 12 (cf. Report of the Imperial Economic Botanist for 1926-27). This type resembles Type 12 in all important features except that its seeds are fawn-coloured and not brown as those of Type 12. The main morphological and agricultural characteristics of Type 124 are as follows :—

Seeds fawn-coloured, small ; corolla white, tinged with blue ; stamens, anthers, filaments, and styles white. It is a late variety with a more or less erect habit of growth, and is one of the most promising and high-yielding types of linseed now available in the Botanical Section at Pusa.

The seed was sown in seven rows in each plot, the distance from row to row being one foot. Germination was good in all the plots. The sowing was rather late and the plants remained a little undersized, but on the whole the crop continued to grow well except that a few plants were damaged by the caterpillar of a cut-worm-moth (*Agrotis* sp.). The crop received three irrigations of two inches each during its period of development. Each plot was given exactly the same amount of water and at the same time. The water was applied by means of a water-can in order to obtain uniform distribution. The amount of monthly rainfall recorded

in the Botanical Area from the 15th November, 1928, when the crop was sown, to the 15th April, 1929, when it was harvested, is as follows :—

Period	Amount of rainfall in inches
15th November to 31st November	*Nil*
December 1928	0·14
January 1929	1·27
February 1929	*Nil*
March 1929	0·87
1st April to 15th April 1929	*Nil*
TOTAL FOR 5 MONTHS	2·28

It may also be mentioned that the linseed crop usually grows without artificial irrigation in this part of the country, as sufficient moisture is preserved in the soil during the rainy season, etc., the average annual rainfall being about 47 inches. In the particular experiment under consideration the need for watering the crop was felt for the reason that the lysimeters in reality are merely large pots made of "pucca" masonry work all round and at bottom, and have therefore no connection with the soil moisture below.

Three weeks after sowing, *i.e.*, on the 8th December, 1928, the crop in each plot was thinned out, leaving only sixteen plants in each row. The plants at the end of rows, plants whose neighbours had died and all those which were even partly damaged at any stage of their life were excluded from the observations. Altogether one hundred plants under each of the five different treatments as regards the fertilizers applied have been considered for the purpose of this article. All these precautions have no doubt added greatly to the uniformity of the results obtained.

The effect of fertilizers applied has been studied mainly on the following characters :—

(*a*) Height of plants.
(*b*) Number of basal branches.
(*c*) Date of flowering.
(*d*) Yield of seed.
(*e*) Oil-content.

The features of interest observed with regard to each of these characters are given below :—

(*a*) *Height of plants.*—The first measurements were recorded on the 15th December, a month after sowing. After this date the heights of plants were measured fortnightly up till the 15th March when the plants showed no further increase in height. The mean heights as determined by fortnightly measurements of 100 plants in each of the differently treated plots are shown in Table I, and graphically in Figure 1 below.

TABLE I.

No.	Soil treatment	Mean height in centimeters on 15—12/28	30—12/28	14—1/29	29—1/29	13—2/29	28—2/29	15—3/29
1	Control	3·52	7·05	17·06	26·95	38·83	41·35	41·35
2	Sodium nitrate @1 md. per acre.	3·20	7·51	17·54	28·57	40·48	43·2	43·2
3	Potassium sulphate @2 md. per acre.	3·37	6·72	15·85	27·29	39·13	40·78	40·78
4	Superphosphate @2 md. per acre.	3·52	6·05	15·35	24·62	36·07	38·92	38·92
5	Complete (consisting of Nos. 2, 3, 4 above).	3·75	7·06	16·57	28·01	40·42	42·6	42·6

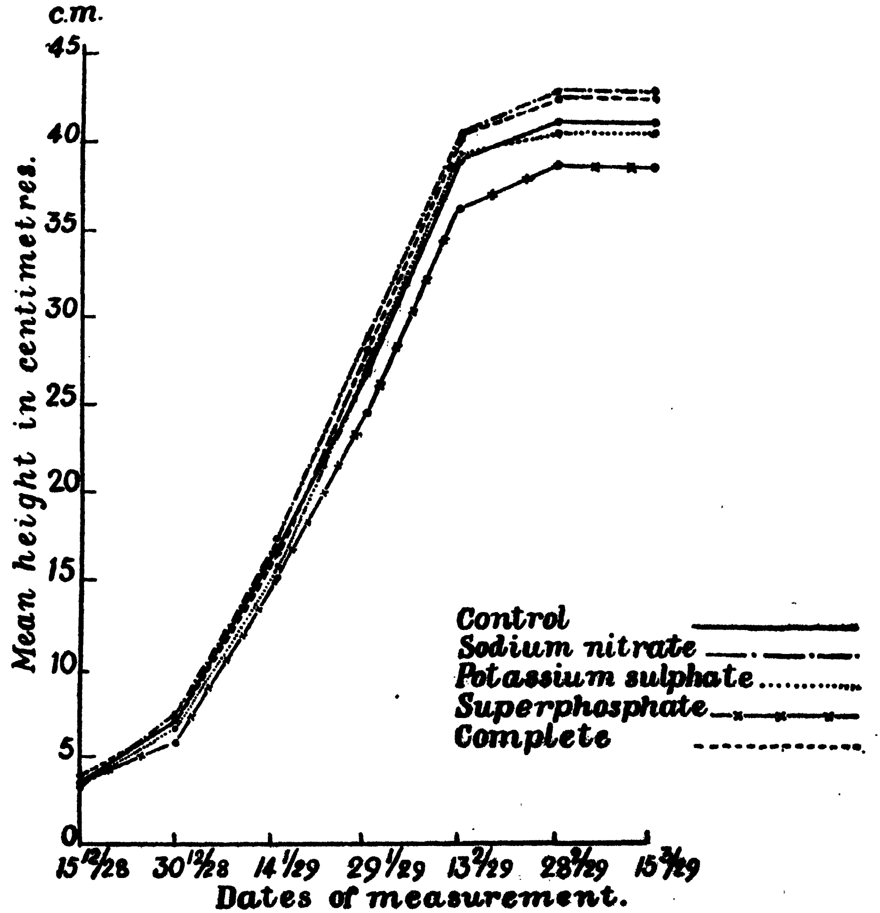

Fig.-1

It will appear from the Table and the figure given above that, on the whole, the plants treated with sodium nitrate and complete fertilizer show considerably greater height than those to which potassium sulphate or no manure was added. The application of superphosphate, on the other hand, appears to have caused a reduction in the height of plants as shown by the growth curve running lowest in that case throughout. The maximum growth of height as observed in each case took place in the fortnight preceding the 13th February, when the fifth measurement was taken. It is of interest to note here that the flowering of plants also commenced during this fortnight, the first formed flowers having been recorded on the 5th February. The plants in all the differently treated plots apparently attained their maximum heights by the end of February, when the sixth measurement was taken. No increase in the height of plants seems to have taken place after that date. The frequency table and curves showing the distribution of the maximum height of 100 plants as measured on 28th February 1929 in each case are shown below :—

Frequency table showing the distribution of the maximum height of 100 plants under different treatments, as measured on 28th February 1929.

(C.V.) Class value in cm.	(F.) Frequencies				
	Control	Sodium nitrate	Potassium sulphate	Super-phosphate	Complete manure
31	2	1	4	3	0
34	4	2	5	16	3
37	18	8	20	25	7
40	23	21	25	29	21
43	35	33	31	24	35
46	13	22	9	3	25
49	4	8	5	0	8
52	1	4	1	0	1
55	0	1	0	0	0
Mean-maximum height in cm.	41·35	43·20	40·78	38·92	42·60

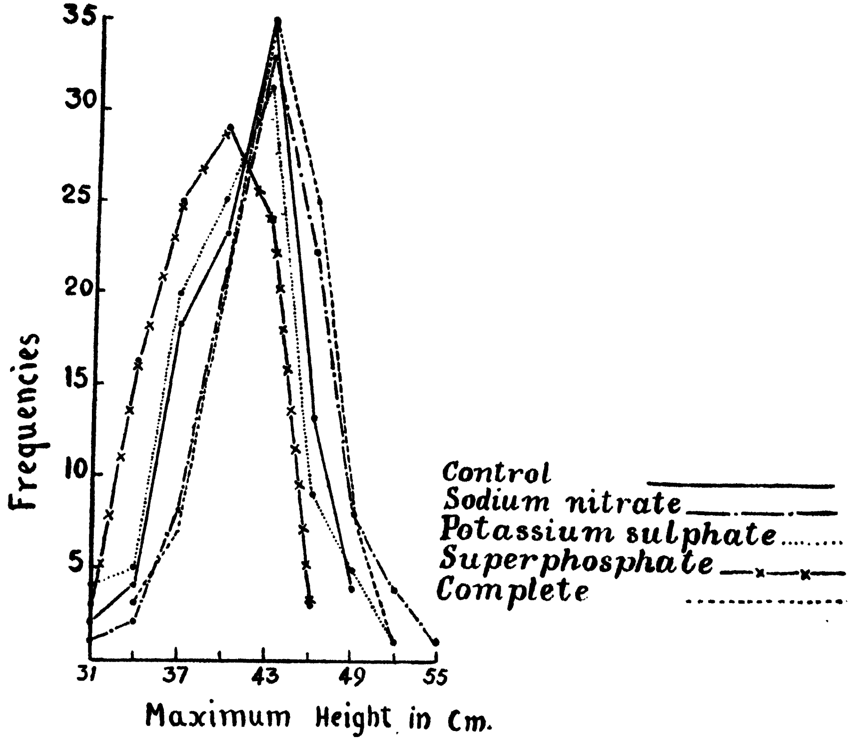

Fig. - 2

It will again be seen from this figure that the maximum height of plants in the case of plots treated with superphosphate is the lowest, the mode in this case being at 40 cm. as against 43 cm. in each of the remaining four cases. The plots treated with sodium nitrate and complete fertilizer show the greatest maximum height. Table II below shows the mean maximum heights with their probable errors as worked out from the frequency curves given above.

TABLE II.

No.	Soil treatment	Mean maximum height in cm.	Probable error
1	Control	41·35	±0·25
2	Sodium nitrate	43·2	±0·28
3	Potassium sulphate	40·78	±0·28
4	Superphosphate	38·92	±0·24
5	Complete fertilizer	42·6	±0·24

In order to see how far the differences in the maximum height of plants are significant, the probable errors of the differences in the heights of plants got between the control and each of the manured plots have been worked out, and the results are tabulated below :—

TABLE III.

Soil treatment	Difference (d) in maximum height as compared to control	Probable error of the difference (Ed.)	$\frac{d}{Ed.}$	Odds
	cm.			
Sodium nitrate	+1·85	0·37	5·0	1,350·35 to 1.
Potassium sulphate	—0·57	0·37	1·5	2·21 to 1.
Superphosphate	—2·43	0·34	7·0	474,782 to 1.
Complete fertilizer	+1·25	0·34	3·9	116·23 to 1.

The significance of the differences above noted is shown in the last column of Table III, the respective odds having been quoted from Pearl's Tables.[1] The increase in height shown by sodium nitrate as compared to the control is roughly 5 per cent., and is shown to be quite significant. Similarly the decrease in height caused by superphosphate is also roughly 5 per cent., and is most significant. Complete fertilizer has also shown a little over 3 per cent. increase in the height of plants, and the difference obtained is fairly significant. The small difference observed in the height of plants treated with potassium sulphate cannot be regarded as significant, the odds in this case being very few. Taking the two extreme cases into consideration, *i.e.*, the maximum heights of plants from the plots treated with sodium nitrate and superphosphate, it will be seen that the difference in height is 4·28 cm., giving an increase of a little over 10 per cent. in favour of sodium nitrate. This difference is extremely significant, $\frac{d}{Ed.}$ being 11·8 and the corresponding odds being much more than 1,470,588,234 to 1, which figure is quoted for the $\frac{d}{Ed.}$ value of 8 in the list above referred to.

From the results described above it is quite clear that different inorganic fertilizers applied to linseed control the height of plants to a considerable degree.

(*b*) *Number of basal branches.* Along with the height of plants, the number of basal branches was also recorded in each case. Table IV below gives the average number of branches per plant as noted on different dates.

[1] Babcock and Collins. *Genetics Laboratory Manual*, p. 49.

TABLE IV.

Soil treatment	Average number of basal branches per plant on				
	15th December 1928	30th December 1928	14th January 1929	29th January 1929	13th February 1929
Control	*Nil*	2·59	6·03	8·44	8·44
Sodium nitrate	*Nil*	3·17	6·90	9·73	9·73
Potassium sulphate	*Nil*	2·81	5·70	8·70	8·70
Superphosphate	*Nil*	1·96	4·92	9·17	9·17
Complete fertilizer	*Nil*	2·75	6·20	9·30	9·30

Table IV shows that the plants continue to grow without giving off any basal branches for at least a month after sowing, when the observations were recorded for the first time in this experiment. No new basal branches developed on the plants after the 29th January, 1929. As already stated, the plants began to flower about a week after this date. The average maximum number of basal branches in the plots treated with fertilizers is in each case higher than that of the control (*see* last column of Table IV above). The increase in this respect is greatest, *i.e.*, about 15 per cent., in the case of the plot treated with sodium nitrate. Next comes complete fertilizer giving an increase of about 10 per cent.

(*c*) *Date of flowering.* The study of the effect of fertilizers on the date of flowering of plants was an after-thought, and therefore no records of the dates of flowering of individual plants in each case were kept from the beginning; but, while recording the height, etc., of plants on the 13th February, it was noticeable that whereas all the plants in the plots treated with superphosphate were in flower, there were a certain number of plants in each of the remaining plots not showing even a single flower on that date. The percentage of plants in flower till then was therefore recorded, and the data obtained are given below :—

Soil treatment	Per cent. of plants in flower on 13th February 1929
Control	82
Sodium nitrate	83
Potassium sulphate	78
Superphosphate	100
Complete fertilizer	80

All the remaining plants, however, came into flowers within two days after this date. As already mentioned, the flowering in certain plants had begun on the

5th February and by the 15th February all plants in all the plots began to flower, so that the plants which formed their first flower earliest were only at the most about 10 days earlier in this respect than the plants which were the last to come to flower. This interval of 10 days or so is too small to attach any great importance to the difference shown above. Nevertheless there is a clear indication of the fact that the addition of superphosphate induced early flowering. This is a point of great interest, when considered with reference to the effect of different fertilizers on the heights of plants. It has been already observed that the addition of superphosphate resulted in about 5 per cent. reduction in the height of plants as compared to the control. It, therefore, follows that superphosphate while checking the vegetative growth of plants induces early flowering. Whether this apparent function of superphosphate can be of any practical or economical use in the production of linseed crop is a matter which requires further investigation, but, as will be shown later in this article, the application of superphosphate on the whole does not appear to give any encouraging results under the conditions obtained at Pusa.

(*d*) *Yield of seed.* The following comparative yields of seed were obtained from the differently treated plots :—

TABLE V.

Treatment	Yield per 100 plants in grams	
	Total	Increase or decrease over control
Control	361	..
Sodium nitrate	382	+21
Potassium sulphate	360	—1
Superphosphate	339	—22
Complete fertilizer	375	+14

These figures show that, as compared to the control, sodium nitrate and complete fertilizer gave approximately 6 per cent. and 4 per cent. increase in yield respectively. Potassium sulphate had no effect and superphosphate showed about 6 per cent. reduction in the weight of seed per 100 plants. Yield trials on a large scale are, however, necessary to ascertain the agricultural and economic value of these fertilizers.

Correlation between yield of seed and height of plants or number of basal branches.

As will be observed from the figures given above, plants treated with sodium nitrate and complete fertilizer give higher yields of seed as compared to the control, and those treated with superphosphate produce comparatively less yield. We have also seen from the results mentioned in paragraphs (*a*) and (*b*) above that the application of sodium nitrate and complete fertilizer caused an increase in the height and number of basal branches as compared to the control, and that of superphosphate showed a similar decrease in the height of plants. Reduction in the height of plant would naturally mean reduction in the length of basal branches also. This at once suggests that there must be some positive correlation between the yield and the height of plants or the number of basal branches. A more thorough study of the factors concerned is, however, necessary to make any definite statement as to how far such a relationship, if any, exists. A detailed study of 100 plants was made with a view to get some definite idea with regard to this question. These plants were taken from four different plots, namely, the control and those treated with sodium nitrate, potassium sulphate and complete manure. The plants of all these plots have their mode at 43 cm. as regards height (Fig. 2). Fifty of these plants were taken at random from the plants having a class value of 40 cm. and the remaining 50 plants from those having a class value of 46 cm. These two classes of plants lie close to the mode on either side, and therefore they represent the majority of plants in each case.

Of the 50 plants belonging to each of the classes having a height of 40 cm. and 46 cm. respectively, the frequency distribution of yield of seed for plants 40 and 46 cm. high is shown in Table VI and graphically represented in Figure 3 below :—

TABLE VI.

Number of plants showing different yields of seed.

Yield in grams	1·1 to 1·5	1·6 to 2·0	2·1 to 2·5	2·6 to 3·0	3·1 to 3·5	3·6 to 4·0	4·1 to 4·5	4·6 to 5·0	5·1 to 5·5	Total No.
Class value in grams	1·25	1·75	2·25	2·75	3·25	3·75	4·25	4·75	5·25	
Height of plants in cm.—										
40 . . .	3	2	6	7	9	13	7	3	0	50
46 . . .	0	1	2	7	9	10	4	15	2	50

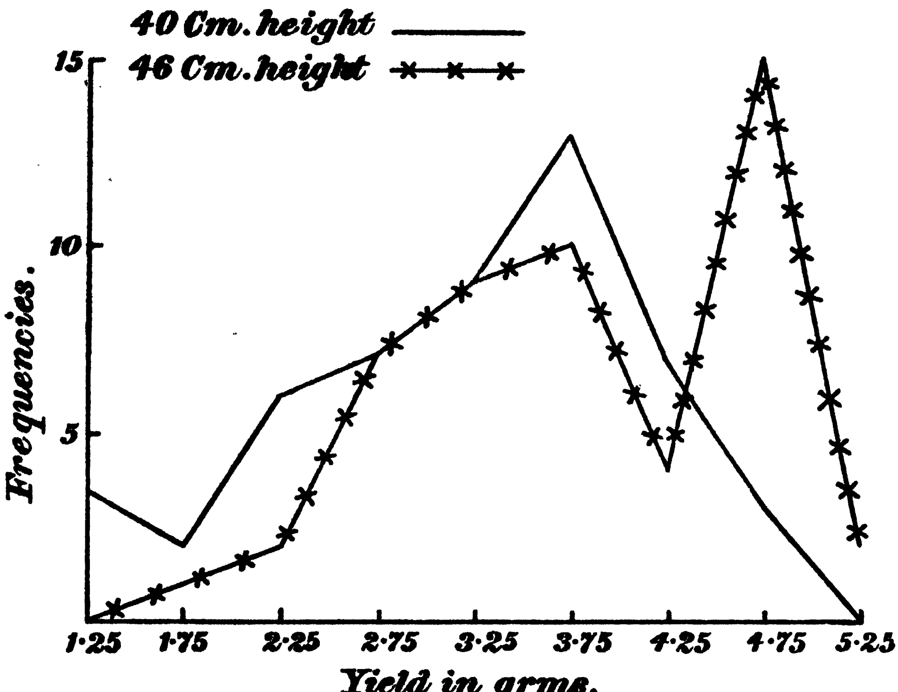

Fig. 3, Showing the distribution of yield of seed for plants 40 & 46 Cm. in height.

According to the above figures, the average yield per plant for the two classes having 40 cm. and 46 cm. height is 3·2 and 3·8 grams, respectively, so that the plants with greater height on the whole give a greater average yield of seed, but a close study of Table VI and Figure 3 given above would show that the number of plants giving different yields of seed does not differ greatly in the two cases and the frequency curves show a considerable overlapping. No definite relationship can therefore be apparently established between the yield and the height of plants. In order to see how far the number of basal branches is correlated with the yield of seed, the data for the same 100 plants as mentioned above may be considered. The following Table shows the number of plants having different number of branches and the average yield of seeds per plant in each case.

TABLE VII.

Height 40 cm.			Height 46 cm.		
No. of plants (Frequency)	No. of basal branches	Average yield per plant in grams	No. of plants (Frequency)	No. of basal branches	Average yield per plant in grams
5	5	1·7	*Nil*	5	..
4	6	2·3	4	6	2·5
12	7	3·0	5	7	3·0
5	8	3·6	4	8	3·6
7	9	3·6	3	9	3·6
4	10	3·7	7	10	4·0
4	11	3·9	13	11	4·2
7	12	4·0	10	12	4·4
2	13	4·7	4	13	4·5

The above Table clearly shows that, as the number of basal branches increases, the yield of seed also increases in each of the series of plants having a height of 40 cm. and 46 cm. It may also be noted that the increase in yield is on the whole slightly higher in the case of plants having a height of 46 cm. than that in the case of plants measuring 40 cm. in height. Considering these two series of plants of different heights, there is a positive correlation between the number of basal branches and the yield of seed (Tables VIII and IX).

TABLE VIII.

—	Yield per plant in grams										
	C.V.	1·25	1·75	2·25	2·75	3·25	3·75	4·25	4·75	5·25	Total
No. of basal branches	5	2	2	1	..	..	..	..	..	..	5
	6	1	0	2	0	1	..	..	..	..	4
	7	..	..	2	4	5	1	..	..	..	12
	8	..	..	1	0	0	3	1	..	..	5
	9	..	..	..	1	1	4	1	..	..	7
	10	..	..	..	1	1	0	2	..	..	4
	11	..	..	..	1	0	1	2	..	..	4
	12	..	..	..	..	1	4	0	2	..	7
	13	..	..	..	..	..	..	1	1	..	2
Total	..	3	2	6	7	9	13	7	3	..	50

TABLE IX.

—		Yield per plant in grams									
	C.V.	1·25	1·75	2·25	2·75	3·25	3·75	4·25	4·75	5·25	Total
No. of basal branches	5	..	..	..	..	..	..	..	..	..	..
	6	..	1	1	2	..	..	..	..	..	4
	7	..	..	1	2	1	1	..	..	..	5
	8	..	..	..	..	2	2	..	..	..	4
	9	..	..	..	1	0	1	1	..	..	3
	10	..	..	..	1	1	2	0	3	..	7
	11	..	..	..	1	3	2	1	6	..	13
	12	..	..	..	..	2	1	1	5	1	10
	13	..	..	..	..	..	1	1	1	1	4
Total	..	..	1	2	7	9	10	4	15	2	50

The correlation co-efficient between the number of basal branches and the yield per plant as worked out for the 40 cm. population (*vide* Table VIII above) is $+0{\cdot}67 \pm 0{\cdot}052$ and that for the 46 cm. population (*vide* Table IX) is $+0{\cdot}58 \pm 0{\cdot}063$, showing thereby that there is a high positive correlation between the two factors considered. We may, therefore, conclude that, the height of plants being the same, the number of basal branches is positively correlated with the yield of seed. It has also been shown above in Table VII that, the number of basal branches being the same, the plants having 46 cm. height, on the whole, show higher yield of seed than the plants having 40 cm. height. The number of plants considered in these cases, however, is not enough to work out a definite correlation co-efficient, but, in view of the results stated above, both the factors, *viz.*, the height of plants and the number of basal branches, should be taken into consideration when making selections of the most promising plants from a given culture. From the data given above it follows that tall growing plants of linseed having a large number of branches should be preferred for the purpose. This is true for at least Pusa conditions where the investigations were carried out ; and when making selections of promising plants from hybrid-segregating-cultures, the erect habit of growth with a larger number of branches should be chosen. It may, however, be pointed out that the same rule may not be strictly applicable to all conditions, and that plants of a different habit may be better adapted to other parts of India. The best way is to collect data on the above lines for the particular locality and the variety under consideration, and then find out the best possible habit factor under these conditions with a view to successfully carry on the work of selection and improvement of the crop concerned.

(*e*) *Oil-content.* Samples of seeds from each of the differently treated plots have been kindly analysed by the Imperial Agricultural Chemist, Pusa. The results got are tabulated below :—

TABLE X.

Soil treatment	Sample No.	Per cent. oil-content in each sample	Average per cent. of oil-content under different soil treatments	Differences as compared to control
Control	A	35·73	35·68	..
	B	35·90		
	C	34·88		
	D	36·24		
Sodium nitrate	A	34·64	34·44	—1·24
	B	34·24		
Potassium sulphate	A	35·96	35·35	—0·33
	B	34·74		
Superphosphate	A	36·02	36·40	+0·72
	B	36·78		
Complete fertilizer	A	35·48	36·39	+0·71
	B	37·30		

Table X shows that the difference between the average percentage of oil-content of seeds from the manured plots and that from the control varies from 0·33 to 1·24. This small difference is certainly not worth consideration when we find from the same Table that some of the samples of seed got from the plants under one and the same treatment show even greater differences ; for example, samples C and D under control show a difference of about 1·3 per cent., and samples A and B under complete fertilizer show a difference of about 1·8 per cent. in their oil-contents. There is therefore no effect shown by any of the fertilizers applied on the percentage of oil-content in linseed.

It may be mentioned, however, that all the samples belonged to Type 124 and that the percentage of oil-content as shown by any of these samples is much lower

than what was found to be in the samples of the same type grown in the Botanical Area in the past few years. The figures kindly supplied by the Imperial Economic Botanist as showing the percentage of oil-content in Type 124 grown in the Botanical Area in different years are as follows :—

Year	Per cent. of oil-content
1926	42·05
1927	40·91
1928	42·65
1929	38·22

There is a difference of over 4 per cent. between the oil-contents of Type 124 grown in the Botanical Area in the two years 1928 and 1929. All these data indicate that the percentage of oil-content in one and the same type of linseed may vary under different environments. A detailed study of the factors involved would, therefore, be of great value from the point of view of the improvement of the crop. The data in hand at present are not enough to throw much light on the subject, but there is a clear indication of the fact that the problem is of great practical importance and needs to be investigated thoroughly for a number of years.

G. L. C. Howard and A. Rahman Khan have stated, in their Memoir above referred to, that there is a certain amount of correlation between the size of seed and the oil-content. The information collected by the author of this paper during his recent tour to many parts of India also shows that the commercial firms dealing in linseed offer a higher price for the larger seeds, as these are known to yield a higher oil-content. It would, therefore, be of interest to see the effect of seasonal variations on the development of seeds and the consequent effect on their oil-content. Along with the seasonal factors the soil-moisture also requires a careful consideration. The question of water-supply is not of any considerable importance in a Province like Bihar where the rainfall is usually quite sufficient and the crops are generally grown without artificial irrigation, but the problem is of great importance in areas receiving comparatively less rainfall and where the successful cultivation of the crop depends mainly on the means of artificial irrigation. For instance, the work carried on by Milne in the Punjab for several years has clearly demonstrated that the seasonal factors and the soil-moisture have a very great influence on the development of fruits and seeds of crops like cotton, wheat, gram, etc. He [1] has published very extensive data to prove that dry atmospheric conditions coupled with the insufficiency of water-supply in the soil, during the flowering and fruiting season of the cotton-crop, seriously affect the development of fruits, and that both the lint and the seed got from such plants are extremely poor in quantity and quality. These and other similar investigations with which the author of this paper has been directly

[1] Milne, D. *Reports on the enquiries into the complaints regarding cotton crop for the years 1919 and 1921.*

associated in the Punjab were of special interest in showing that in many cases the crops receiving adequate water-supply in irrigated areas had little cause for complaint, and that very often an omission of even one irrigation during the critical period of the development of plants may result in the failure of the crop concerned. It is, therefore, necessary to carry on similar researches with regard to the growth and development of the linseed crop in the Punjab, and the author hopes to continue the work on the lines suggested after his return to the Province.

Summary.

1. The effect of the following fertilizers on the growth and oil-content of a variety of linseed (T. 124) has been studied :—

(*a*) Sodium nitrate, at one maund per acre.

(*b*) Potasium sulphate, at two maunds per acre.

(*c*) Superphosphate, at two maunds per acre.

(*d*) Complete fertilizer ($a+b+c$).

2. Fortnightly measurements of height and the number of basal branches were recorded. Maximum growth in height took place during the sixth fortnight after sowing, when flowering also commenced. The maximum growth in height was attained at the end of the ninth fortnight after sowing in all cases.

3. No new basal branches developed on the plants in any bed after at least a week before flowering commenced.

4. Sodium nitrate and complete fertilizer appear to cause an increase of 5 per cent. and 3 per cent. respectively in the maximum height of plants as compared to the control. Potassium sulphate shows no effect and superphosphate appears to show 5 per cent. reduction. The differences obtained are shown to be significant.

5. Sodium nitrate and complete fertilizer appear to cause 15 per cent. and 10 per cent. increase in the average number of basal branches per plant respectively.

6. Sodium nitrate and complete fertilizer also show 6 per cent. and 4 per cent. increase in the yield of seed respectively. Potassium sulphate has no effect, and superphosphate shows about 6 per cent. reduction in yield as compared to the control, but induces early flowering.

7. Increase in height and the number of basal branches caused an increase in the yield of seed. The height of the plants being the same, the number of basal branches was positively correlated with the yield. The co-efficient of correlation worked out in two cases was $+0{\cdot}67 \pm 0{\cdot}052$ and $+0{\cdot}58 \pm 0{\cdot}063$ respectively.

8. The importance of habit-factor in the selection of promising plants has been indicated.

9. No remarkable effect has been shown by any of the fertilizers applied on the percentage of oil-content of linseed.

10. The percentage of oil-content of one and the same type of linseed varies from year to year. The factors concerned need to be further investigated.

NOTES ON INDIAN COTTONS.

BY

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The following Table gives some idea of the distribution of the Indian cotton crop according to the trade descriptions, the blow room losses sustained by the different growths, and the types of yarn for which they are severally suitable.

Hedge Contract	Trade description of cotton	Acres (Thousands) 1929-30	Bales* (Thousands) 1929-30	Yield per acre	Blow room loss per cent.	Counts
Bengals	United Provinces	932	342	147	9·11	8/10's reeling or weft yarn.
	Rajputana	540	115	85		
	Sind-Punjab	1,981	579	117		
	Others	76	15	79		
	Total Bengals	3,529	1,051	119		
Broach	Broach-Ankleshwar	1,304	281	86	10	18/20's weft.
	Surat				8	20/22's warp.
	Saw-ginned Dharwar				10	20's warp.
	Navsari				7	30's warp.
	Punjab-American	825	253	123	9·10	40's weft.
	Sind-American	27	8	119		20/24's warp.
	Dholleras	2,784	522	75	14·16	20's weft.
Oomras	Khandesh	1,862	248	73	11·12	10/12's reeling.
	Central India	2,021	338	67	14	16/20's weft.
	Barsi	3,590	472	58	14	16/20's weft.
	Nagar				14	12/14's reeling.
	Hyderabad-Gaorani				14	24's warp.
	Berar				11	12/14's reeling.
	Central Provinces—No. 1	5,167	1,142	88	7	16/18's reeling.
	No. 2				9	12/14's reeling.
	Total Oomras	12,140	2,200	72	..	
Southerns	Coompta-Dharwars	1,685	291	69	13·15	22/28's warp.
	Westerns	1,472	161	44	15	16/20's warp.
	Northerns				14	20's warp.
	Cocanadas	225	37	66	14·15	14's warp, 20's weft.
	Tinnevellys	596	159	107	9	20's weft.
	Salems	242	42	69	9	14's warp.
	Cambodias	408	151	150	9	30's warp, 40's weft.
	Comillas, Burmas and others.	460	104	90	9	8/10's reeling.
	GRAND TOTAL	25,692	5,260	82	..	

* These figures are those of the Supplementary Estimate of the Government of India issued on April 24, 1930; later information available from the Cotton Press Returns indicates that the actual crop of 1929-30 is probably some 20 per cent. higher.

In the "counts" column of the Table, reference is frequently made to "reeling" as the type of yarn for which the given cotton is suitable; it may be explained that reeling is yarn specially made for the Indian handloom industry; nearly half the cloth woven in India is woven in handlooms, so that the demand for yarn set up by this industry is exceedingly large.

It will be seen from the Table that the total 1929-30 crop consists of about one million bales of Bengals, one million bales of Broach, 2¼ million bales of Oomras, and one million bales of Southerns. Now all the Bengals and all the Oomras, except Hyderabad-Gaorani and a new cotton, Verum 262, are comparatively low class cottons. The Bengals particularly is short, coarse, and harsh in staple; it is for this reason that it can only be spun in coarse counts. We are therefore left with the Hyderabad-Gaorani, Verum, the Broach, and the Southerns cottons—amounting in all to two million bales.

All the cottons coming under the Broach contract are grown in Bombay Presidency, with the exception of the Punjab-American. All the cottons coming under the Southerns contract are grown in Madras Presidency, with the exception of the Coompta-Dharwars, which are grown in the southernmost part of the Bombay Presidency.

In considering these longer-staple and better-class cottons the standard of reference is that adopted in "Technological Reports on Standard Indian Cottons". Put briefly, this standard requires that a 20's cotton spun with 17·98 turns per inch shall give a test of 67 lb; cottons of higher quality and suitable for higher counts will naturally give a much higher test for 20's when spun with this degree of twist.

We may now consider the properties of the different longer-staple cottons: figures are given showing the size of the crop in each case, but all these figures are of course very approximate, and are subject to large fluctuations according as the season is good or bad.

Broach-Ankleshwar: Production 100,000 bales.

A soft or slightly rough cotton, creamy in colour; the fibre is rather weak; ordinarily this cotton will spin in the neighbourhood of 20's weft, but this year the quality has been poor and even with 20·23 turns per inch the lea test for 20's was only about 50 lb. This cotton would usually be regarded as a weft cotton, but it is frequently used in India for warp on account of its price.

Surat-Navsari: Production 100,000 bales.

This cotton is a Government selection (1027 A. L. F.) which is grown largely in the Broach and Surat Districts, adjacent parts of Baroda State (Navsari District), and in Rajpipla State where it is the sole variety allowed to be grown. The cotton comes on to the market as Surat, Navsari, Rajpipla, and Jagadia Farm (a cotton centre in Rajpipla State). It is a white to creamy-white cotton, with a soft and silky feel, and makes a good warp suitable for standard counts up to 34's.

Punjab and Sind-Americans : Production 261,000 bales.

This cotton is almost entirely the Government selection 4 F, which is grown under canal irrigation. It is creamy-white in colour, and has a silky good bodied feel; it usually makes a good 20's warp, though occasional poor lots are not satisfactory for more than standard 16's warp.

Included in the Punjab-Americans are the superior Government strains 285F and 289F, the latter of which has largely superseded the former. The total production of 289F is not more than a few thousand bales, largely grown under the direction of the British Cotton Growing Research Association (Punjab), Ltd., Khanewal. This 289F has a long staple (commercially $1\frac{1}{8}$ inch), is bright and creamy-white in colour, with a nice soft feel. Its chief defect is nep, from which it suffers in an exceptionally high degree in bad seasons. It spins up to 40's counts carded, and is quite suitable for 60's or even higher counts when combed.

Dholleras : Production 522,000 bales.

This cotton is grown in Kathiawar, and is suitable for about 20's weft. The staple length is about a commercial $\frac{7}{8}$ inch. It has a silvery colour, but its great defect is its exceptional leafiness, which, being of a peppery kind, it is difficult to remove completely. Similar cottons are Kadi-Viramgam and Kalagin, the latter of which has this year given a very good 20's warp.

Coompta-Dharwars : Production 291,000 bales.

The Coompta cotton has a staple length of $\frac{7}{8}$ inch. Its defects are its creamy colour and its extreme leafiness. It has a good soft but bodied feel. Dharwar 1 and Jayawant are selected superior strains and suitable for standard counts up to 34's; the total production of these superior strains is approximately 40,000 bales.

Saw-ginned Dharwar is a Dharwar-American which is grown particularly round Gadag. The "selected" type is Gadag 1, with a production of 17,000 bales, staple length of $\frac{7}{8}$ inch, creamy-white in colour, with a good bodied feel. It has given a variable spinning performance, in some seasons giving standard warp of 38's but in other seasons decidedly less.

Northerns and Westerns : Production 161,000 bales.

These cottons are grown in the Northern and Western tracts of Madras. The ordinary Westerns is leafy, creamy in colour, full bodied with a good feel and a fairly strong staple. It has a staple length of $\frac{13}{16}$ inch, and is suitable for standard 16's warp and 20's weft. Certain selected types are decidedly superior: Hagari 1, with a production of 20,000 bales in 1929-30, has now displaced Hagari 25, and is suitable for standard warp of 24/26's; it is a somewhat creamy cotton, having a soft and bodied feel, and a $\frac{7}{8}$ inch staple which is fine and strong. Nandyal 14 is a selected Northerns cotton, white to creamy-white in colour, very bright, and possessing a soft bodied feel; its production is 2,000 bales.

Cocanadas : Production 37,000 bales.

This cotton, which is grown in a tract of Madras lying along the Eastern coast, has a staple length of $\frac{3}{4}$ inch. It has a harsh feel, but its most characteristic feature is its comparatively dark brown colour. Some years ago it was suitable for 20's warp, but recently has not done so well, and may now be regarded as suitable for 14's warp or 20's weft.

Tinnevellys : Production 159,000 bales.

This is a mixed cotton of which the best type is Karunganni. Selected strains of Karunganni known as Company cottons are grown to the extent of some 7,000 bales, though in 1929-30 the production was much less. The best of these strains is C. 7, a 1-inch staple cotton, of which the production has attained some 3,000 bales. Ordinarily Tinnevellys are suitable for standard warp counts up to 20's, and Karunganni C. 7 up to 26's.

Salems : Production 42,000 bales.

This cotton is chiefly a variety known as *Uppam* which has a staple of $\frac{13}{16}$ inch, is white to creamy-white in colour, and is suitable for standard warp of 14's counts.

Cambodias : Production 151,000 bales.

This is perhaps the best all-round type of cotton grown in India ; it is a bright cotton, slightly creamy in colour, with a good soft and bodied feel ; the staple is fine, strong, and regular. The best Cambodia—constituting about half the Cambodia crop—is grown under well-irrigation, but the other and inferior half of the crop is grown under " dry " (rain-fed) conditions on an area about twice as large as the irrigated. The selected strain Co. 1, formerly known as Cambodia 295, has a crop of 10,000 bales, but it is now being displaced by the better yielder Co. 2, formerly known as Cambodia 440. Both Co. 1 and Co. 2 have a 1-inch staple ; Co. 1 is suitable for standard warp counts up to 34's and Co. 2 up to 30's.

Hyderabad-Gaorani : Production 70,000 bales.

This cotton is one of the best of the indigenous cottons, having a staple length of $\frac{7}{8}$ inch, creamy-white in colour, with a good soft feel, but usually rather leafy and seedy. The best qualities are suitable for standard warp of 24's. It suffers from the agricultural defect of being a poor yielder, and for this reason stands in danger of being displaced.

Verum 262 : Staple length $\frac{7}{8}$ inch.

This is a white cotton with a soft but good bodied feel, and suitable for standard warp of 20's, or sometimes even more. The development of this cotton has been

most rapid. It was first put out for general cultivation in 1927-28, and was spread over 5,000 acres in 1928-29, while in the present season (1930-31) it covers 150,000 acres which may be expected to produce a crop of some 40,000 bales. The most remarkable thing about this cotton is that it is displacing Oomras low quality cottons, so that if its rapid expansion is continued for the next two or three years, it must produce a great change in the character of Oomras cotton ; and as it is a high-yielding wilt-resistant type there seems to be no reason why this change should not be effected, in which case the general character of the Indian cotton crop will be completely transformed, with reactions upon the nature of the production of Indian mills and on the cotton available for export.

Summary.

If we now sum up the position of the supply of the better-class Indian cottons, we see that at present there is a production of about two million bales suitable for 20's or higher counts ; only a fraction of this, however, is suitable for standard warp counts of 30's, not more than about 300,000 bales in fact ; the only cotton suitable for 40's warp counts is Punjab-American 289F, of which the present season's production may attain some 5,000 bales.

The question arises as to how far these Indian cottons can be used for the substitution of American types ; so far as low grade American cotton is concerned, there is no reason why these Indian cottons should not be used in its place for 20's warp counts ; alternatively, a mixing could be made of the two types. The chief difficulties that are likely to arise are connected with the greater loss which is invariably sustained from the Indian cottons as compared with the American ; the heavier impurities may be removed without difficulty, but the excessive leafiness of some types, especially of Coomptas, is likely to give trouble and lead to a peppery yarn ; whereas the fine staple cottons are apt to be neppy, and this is particularly so in the case of Punjab-American 289F.

There is a keen local demand for all of these better-class cottons—except Cocanadas which is in large part exported to Europe. The Southerns cottons, especially the best qualities, are largely used by the mills in South India, and there is relatively little export of these ; in fact the local demand for these cottons is so great that they are generally bought upon the spot by mill agents, and so they do not take a prominent place in the Bombay cotton market.

SOME OBSERVATIONS ON THE POLLINATION OF PEACHES (*PRUNUS PERSICA* BENTH. AND HOOK.).

BY

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The genus *Prunus* belongs to the order Rosaceæ. It is a native of China and is grown all over India.

In the Botanial Section, Pusa, there is only one plant of "Safaida" variety and there are a few plants of "Hakim" variety, which were originally brought from Delhi and Saharanpur respectively. Some observations made on the pollination of these two varieties of peaches are recorded in this paper, and may prove useful to those who are interested in this line of work. The results are based on observations made in two years.

Description of the genus.

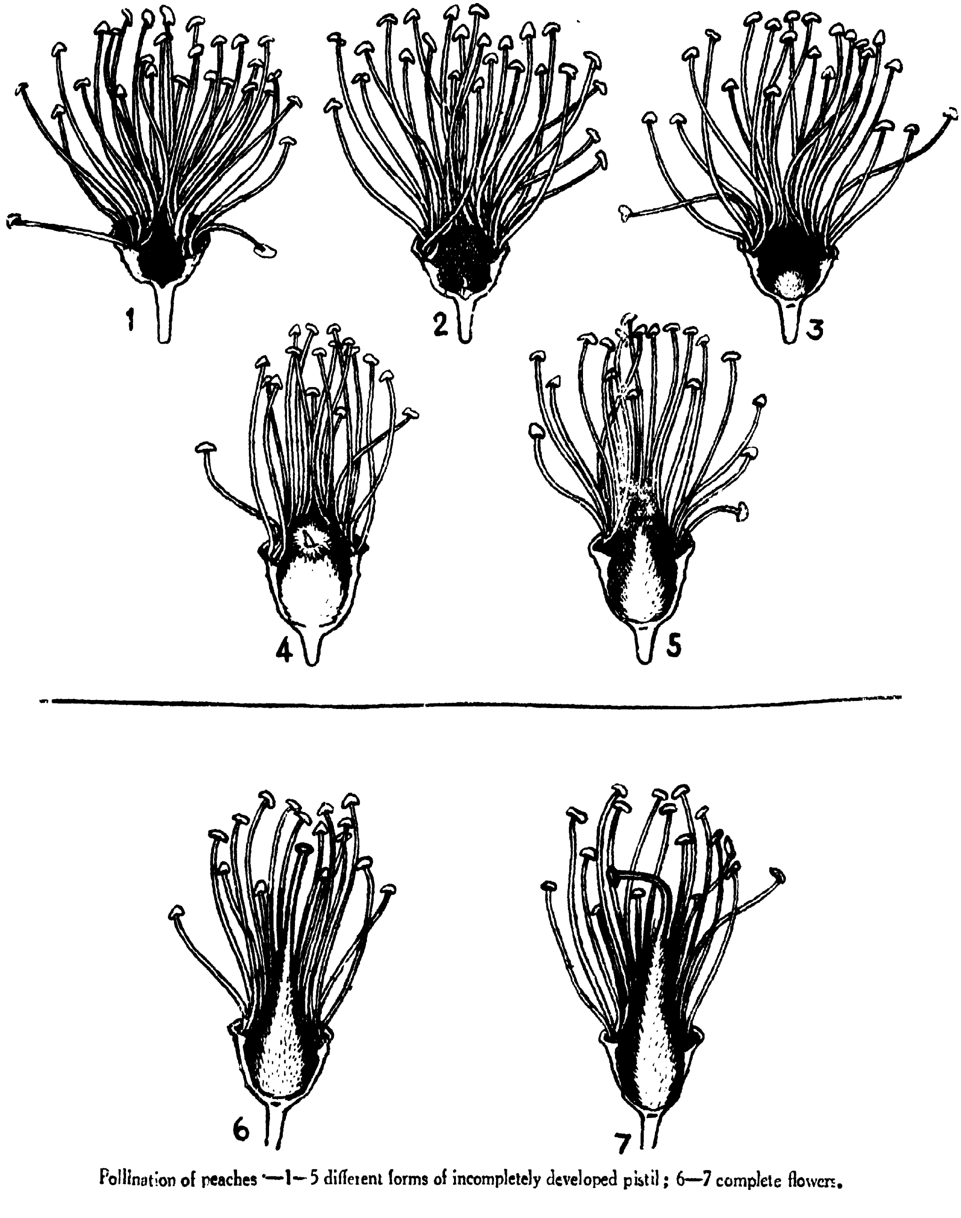
Hooker gives the following description in "The Flora of British India":—

Genus description.—Shrubs or trees, leaves alternate. Flowers in solitary fascicled corymbose or racemed. Calyx deciduous in fruit, lobes 5 imbricate, petals 5, stamens 15-60, perigynous, inserted in the mouth of the clyx tube, filaments free, carpel 1, style terminal, ovules 2, pendulous. Drupe with an indehiscent or 2-valved, 1-seeded, smooth or rugged stone.

Species description.—Leaves appearing after or with the flowers, oblong-lanceolate serrate, petiole glandular, flowers sessile, calyx campanulate, pericarp indehiscent.

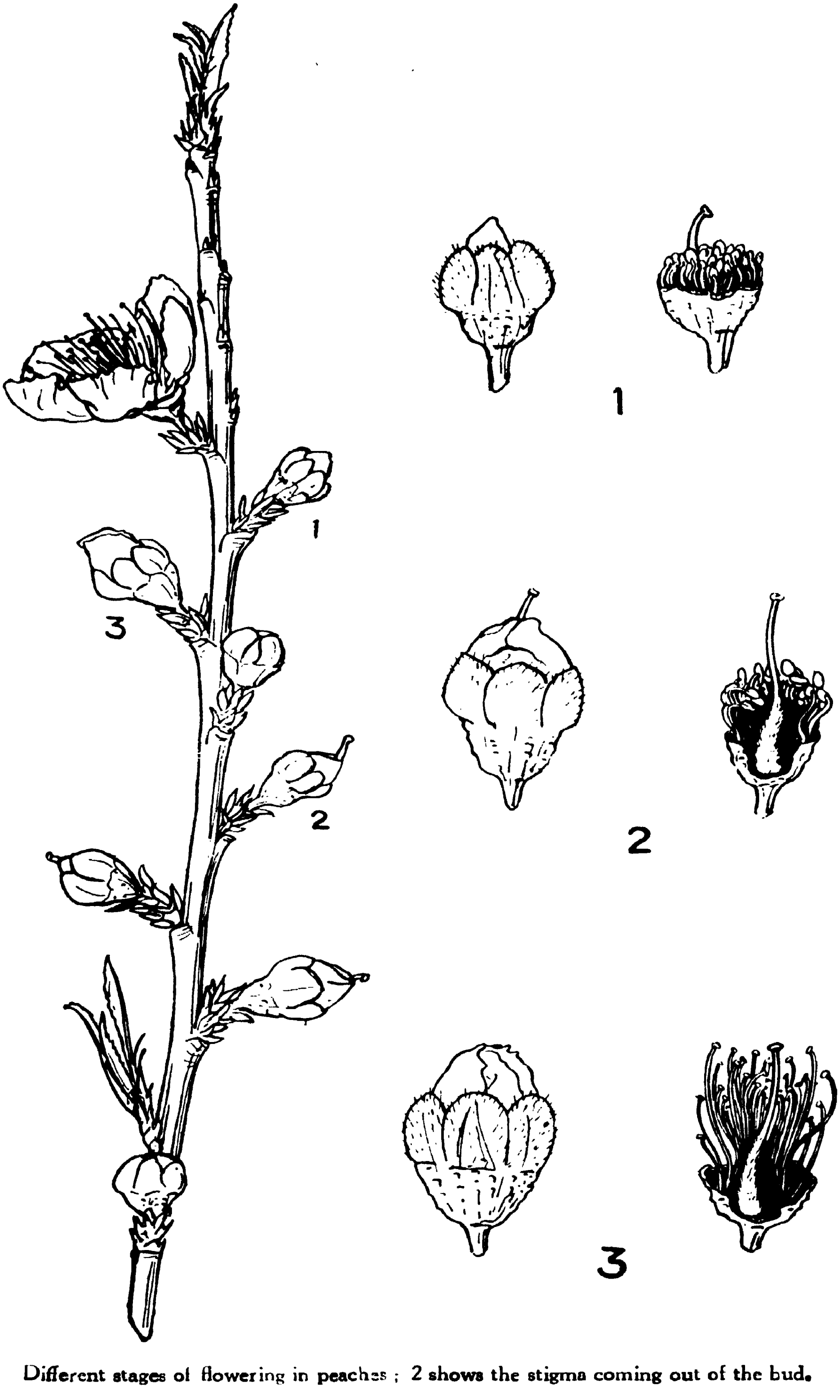
According to the above description all the flowers should be hermaphrodite. But the pistil in some cases has been found to be either completely absent or incompletely developed. In Plate XXX, figures 1 to 5 show different forms of incompletely developed pistil. In figure 1, the pistil is completely absent. In figures 2 to 5, the pistil is present, but is incompletely developed. In all cases the stigma and the style are completely absent. The stamens are quite well-developed in these cases, and these flowers may be called staminate. Such flowers can never produce fruit.

In the same plate figures 6 and 7 show the flowers which are complete in all respects. Stamens are present, and stigma, style and ovary are well-developed. The style was found to be either straight or bent as shown in these figures.



Pollination of peaches :—1—5 different forms of incompletely developed pistil; 6—7 complete flowers.

PLATE XXXI.



Different stages of flowering in peaches ; 2 shows the stigma coming out of the bud.

The percentage of staminate to hermaphrodite flowers was noted in 1,400 flowers, and the result was as follows :—

Year	Date	No. of plants	No. of flowers examined	Percentage of staminate flowers	Percentage of hermaphrodite flowers
1st year . .	28th January	1	100	17	83
„ . .	29th January	2	100	46	54
„ . .	30th January	3	100	22	78
„ . .	17th February	4	100	45	55
„ . .	17th February	5	100	46	54
„ . .	17th February	6	100	36	64
„ . .	18th February	7	100	51	49
„ . .	18th February	8	100	69	31
„ . .	18th February	9	100	66	34
2nd year . .	30th January	10	100	21	79
„ . .	10th February	11	100	21	79
„ . .	11th February	12	100	52	48
„ . .	12th February	13	100	41	59
„ . .	13th February	14	100	27	73
TOTAL .	..	..	1,400	560	840

Out of a total of 1,400 flowers examined, 560 were staminate and 840 were hermaphrodite, thus giving a percentage of 40 staminate to 60 hermaphrodite flowers.

FLOWERING.

In every young bud the petals are enclosed within the calyx, and the stamens and the pistil are enclosed within the petals. As the bud grows, petals emerge out of the calyx though the flower is closed. One day before the opening of the flower the stigma usually comes out of the bud (Plate XXXI, figure 2) and appears to be receptive at this stage.

The following experiment supports the above statement. In the year 1930, seventeen closed buds (in which the stigma had come out of the corolla) were emasculated, crossed and bagged. Out of these ten fruits were formed. This showed that fertilization was possible at this stage. A day after this the petals grow

rapidly, and once more the stigma is enclosed within the corolla. Next morning the flower begins to open at about 10 A.M. and opening is complete by 3 P.M. All the anthers do not burst at the same time. A few may burst in the bud stage just before the opening of the flower, but the majority dehisce after the opening of the flower somewhere between 12 noon and 4 P.M., while the remaining anthers, if any, burst the following day.

SETTING.

The position of the anther is such that selfing generally takes place, but setting under bag seems to be rare. In the first year, 203 buds were protected with paper bags out of which 73 were hermaphrodite and these produced only two fruits. Some flowers were under muslin bags, and these also produced no fruits. In the year 1930 a large number of buds were again covered with muslin bags, and no fruit was formed.

In order to find out the amount of setting in hermaphrodite flowers under natural conditions, 50 hermaphrodite flowers were labelled and were left as such. Only ten formed fruits giving a percentage of 20.

It is evident that cross-pollination is necessary in order to obtain good yield. Bees are the chief agents for cross-pollination. It is necessary that the trees should not be planted isolated from one another, otherwise there would be little chance of cross-pollination. To ensure good setting two or more varieties flowering at the same time may be grown in rows side by side.

In the end the writer desires to acknowledge the assistance received from Mr. A. R. Akhtar, M.Sc., post-graduate student in the Section, in connection with the above work.

A STUDY OF SEX IN THE INDIAN HEMP.

BY

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One of the most debatable problems of genetics is the correct interpretation of the actual mechanism of sex-determination. Two outstanding and seemingly quite contradictory views are held as to the basis of sex-determination [1]. On the one hand there is the theory that sex is predetermined by the chromosome equipment that enters into the zygote. This is commonly known as the chromosome theory. The other point of view is that sex may be determined otherwise than by the chromosomes, the decisive factors being certain physiological conditions surrounding the unfertilized egg or the developing embryo. This constitutes the physiological theory.

According to the first school of thought, the fundamental differences between the sexes are probably genetical, and it is held that the chief factors affecting sex are located in the sex chromosomes. Cytological studies have indicated the presence of an accessory or "X" chromosome in the sperm or in the egg, and this is believed to be the deciding factor in some species. If sex does Mendelize, the chances are even that an equal number of males and females will be produced. Castle [2] quotes examples which support the general conclusion that chromosomes contain the determiners of inheritable characters including those of sex, but that unbalanced conditions of the chromosomes may upset the sex balance also.

The supporters of the physiological theory, on the other hand, believe that various environmental conditions may either modify the sex-ratio or result in the production of intersexes. Schaffner[3] states that "sexuality is primarily a physiological condition; that it is primarily not at all Mendelian in nature and not amenable to Mendelian analysis; that it can frequently be controlled and reversed at will, even with our present crude methods, and that it is pre-eminently a subject of ecological and physiological experimentation". He also maintains [4] that "the development of complex sex mosaics is due to the disturbance brought about by the abnormal environmental conditions, probably largely through a disturbed metabolism, which causes one cell or cell-complex to be thrown into the male state while the neighbour-

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[1] Coulter, M. C. *Outline of Genetics.* Univ. of Chicago Press, 1923, p. 181.
[2] Castle, W. E. *Genetics and Eugenics.* Harvard Univ. Press, Cambridge, 1925, p. 38.
[3] Schaffner, J. H. The Nature and Cause of Secondary Sexual states with special reference to Typha. *Bull. Torrey Bot. Club*, **53**, 1926, 189-208.
[4] Schaffner, J. H. Sex reversal in Japanese Hop. *Bull. Torrey Bot. Club*, **50**, 1923, 73-79.

ing cells remain in the female state or *vice versa*. It seems clear that the more recent notions in regard to sex will need to be revised and restated in agreement with actually ascertained experimental evidence. The notion that sexuality is primarily hereditary in nature and Mendelian will have to be abandoned. It clearly does not appear to be a matter of nuclear and chromosome morphology. The next steps are perhaps now possible—to ascertain something of the real nature of sexuality and a more definite knowledge of sex control in favourable plants. This must, to some extent at least, lead into the fields of ionization in chemistry and electrons in physics; in other words, the biological phenomenon of sex is probably fundamentally physico-chemical and not morphological".

A great deal of controversy still exists in this matter, and the possibility of altering normal sex-ratios in dioecious plants and animals by the influence of external stimuli upon sex-ratios is receiving the attention of many investigators. Plants like *Morus alba*, *Thalictrum dioicum*, *Araisaema triphyllum*, *Zea Mays*, and *Cannabis sativa* have furnished suitable material for a study of reversal of sex. Hemp (*Cannabis sativa*) has been used by many workers with varying success. Although Schaffner and others have procured complete reversal of sex in this plant with the influence of various external stimuli, Kenji Hirata[1] reported that in the variety "Tochigi" the rate of sex-reversal was extremely low, and that in the variety "Karafuto" about 50 per cent. of both male and female plants reversed their sexual expression through the mutilation caused by the removal of certain parts of the branches and stems at the early stage of flowering. He suggests that some hemp plants are pure and that their sex cannot be reversed, while others are impure and reverse their sex easily. The diploid number of chromosomes being 20, the chromosome mechanism in hemp is represented by him as $18+x+y$ for the male and $18+x+x$ for the female.

Before it is possible to draw any conclusions on the influence of external stimuli in producing sex changes we must know the proportion of sex-reversal which normally takes place in the material under experiment. It is the purpose of this paper to describe the behaviour of the commonly cultivated Indian hemp plant to mutilations and other external stimuli under field conditions, and to discuss the nature of sex phenomenon in this plant.

MATERIAL AND METHOD.

In India hemp is generally sown in the beginning of August in seed-beds and then transplanted as soon as the seedlings have attained a height of 6 to 10 inches. For purposes of this study some mixed seed of hemp was obtained from Sabour (in Bihar) in 1925, and the observations recorded in the following pages were made on plants grown from this mixed seed or its progeny. In 1926-27 it was observed, however, that about 21·7 per cent. plants of the total population of that year showed a tendency

[1] Hirata, K. Sex-reversal in Hemp. *Jour. Agri. Forest. Soc. Sapporo* (Japan), 16, 1924, 145-168.

to develop some flowers of the opposite sex at a time when their normal flowering was almost over. This suggested that there was possibly a regular tendency towards monoeciousness in the Indian hemp, and that a true interpretation of results in obtaining artificial reversal of sex could be obtained only if a type which showed little or no tendency towards monoeciousness could be isolated. One culture (No. H-17) that year showed about 1·5 per cent. monoeciousness, and this was therefore selected that year for purposes of this experiment.

A regular census of sex-ratios was made twice every year, once when the plants just began to flower and then again about two months later.

Sex-ratios.

The following sex-ratios in hemp were observed in the Botanical Section, Pusa, during the period 1925-26 to 1929-30 :—

Table I.

Showing sex-ratios observed in hemp.

Year	Nature of seed	No. of plants observed	Sex-ratios in					
			Preliminary census			Final census		
			Male	Female	Mono-ecious	Male	Female	Mono-ecious
1925-26	Mixed .	1,932	1	2·73	0·4	1	3·5	0·5
1926-27	Mixed .	1,690	1	3·44	0·96	1	3·51	1·24
1926-27	Single plant cultures.	1,870	1	2·1	0·63	1	2·34	0·93
1927-28	H-17 .	56	1	3·0	0·0	1	3·3	0·0
1928-29	H-17 .	883	1	1·08	0·004	1	1·11	0·032
1929-30	H-17 .	922	1	1·13	0·004	1	1·07	0·006

It may be observed from the above Table that from 1925-26 to 1926-27 the hemp plants grown from a mixed culture showed a ratio of approximately 1 male to 2 or 3 females, while in 1928-29 and 1929-30 the selected culture, H-17, gave a ratio of roughly 1 male to 1 female. This culture possibly being genetically pure, the divergence in the sex-ratio in 1927-28 from that in the following years is perhaps due to

having taken that year only a very small population in which the effects of differential mortality were not properly balanced out. A preponderance of female plants is a useful character for hemp grown for drug (*ganja*) purposes, as it is only the female plants which produce this narcotic. In selecting out H-17, a culture which showed the least tendency towards natural monoeciousness, the character of producing a heavier proportion of female plants was lost. It might be pointed out that Pritchard[1] has reported that the food theory of sex-determination fails to account for the sex-ratio of 1 male : 1 female commonly found in unisexual individuals, and that the Mendelian theory not only explains sex-ratios in dioecious species but receives considerable support from studies of sex-linked inheritance.

Effect of some manures on sex-ratios.

In 1925-26 one-half of the field in which hemp was cultivated was manured with mustard cake at the rate of 3 cwt. to the acre, while the other half was left unmanured to serve as control. The differences observed in this comparison are shown below :—

Table II.

Showing the effect of a dressing of mustard cake on the sex-ratio in hemp grown from mixed seed.

Treatment of plot	Total number of plants	Number of			Ratio		
		Males	Females	Mono-ecious	Males	Females	Mono-ecious
Manured .	974	230	652	92	1	2·85	0·4
Unmanured .	958	236	622	100	1	2·64	0·4

This showed that there was only a slightly greater preponderance of females in the plot which afforded more nutrition, *i.e.*, which was manured. This result however is not very conclusive.

In 1928-29 the effect of three more fertilizers, *viz.*, superphosphate, ammophos and ammonium sulphate, on the sex-ratios of hemp was observed in culture H-17. The field under the experiment was divided into four equal parts. A top-dressing of one or the other of the above named fertilizers at the rate of 1¼ maunds to the

[1] Pritchard, F. J. Change of sex in hemp. *Jour. Heredity*, VII, 1916, 325-329.

acre was given to three plots, while the fourth was left unmanured for control. The following results were obtained :—

Table III.

Showing the effect of a dressing of some fertilizers on the sex-ratios in hemp grown from single plant seed.

Treatment of plot	Total number of plants	Number of			Ratio		
		Males	Females	Mono-ecious	Males	Females	Mono-ecious
Superphosphate .	397	187	202	8	1	1·18	0·043
Unmanured (control)	393	203	187	3	1	0·92	0·015
Ammophos . .	380	169	204	7	1	1·12	0·041
Ammonium sulphate	362	157	200	5	1	1·27	0·032

This to a certain extent is in conformity with the results reported by Clute[1] in Arisaema, who found that " starvation such as that produced by sterile soils led to a staminate condition while good feeding was accompanied by a carpellate condition ". There is certainly a greater preponderance of male plants in the control plot than is seen in any of the other manured plots. Although the divergence of observation of the sexual inequality between the sexes is scarcely large enough for statistical significance, it may be pointed out that the seed used in 1925-26 was from a *ganja*-producing type which had shown a ratio of about 1 male to 3 females, while the seed used in 1928-29 was from a pure culture showing a ratio of 1 male to 1 female.

Change from dioecious to monoecious condition.

Hemp is dioecious by nature. Seeds although similar in form and apparently of the same constitution produce two different kinds of plants, the males and the females. During the late phases of the life-history of hemp a large number of plants have been observed to become monoecious. In 1926-27 this was estimated to be 21·7 per cent. This departure from the natural dioecious habit to monoeciousness suggests that both types of sex-determiners are present in the body of the plant accompanied by an inhibitor for one of them and resulting in the production of either the male or the female plant, but under certain conditions this sex-inhibitor loses its effect and the activities of both the sex-determiners come into play producing a change from dioecious to monoecious habit.

[1] Clute, W. N. Changing the sex in plants. *Gard. Chron. Amer.* 29, 1925, 18.

A detailed observation in 1926-27 revealed the fact that more male plants than female ones have the tendency of developing flowers of the opposite sex at some stage of their life-history. Of 767 monoecious plants under observation, 539 plants were originally male and they developed female flowers to a varying extent, while the remaining 228 plants were females and formed some male flowers later on. The majority of these male plants produced only a *very few* flowers of the opposite sex, and there were very few plants which showed *many* secondary female flowers. In the female plants, which changed their sex, nearly half of those under observation developed *many* male flowers, while a small number of plants produced *very few* flowers of the opposite sex. This is shown in the following analysis :—

	No. of plants
Male plants with *many* secondary female flowers	14
Male plants with *few* secondary female flowers	173
Male plants with *very few* secondary female flowers	352
TOTAL	539
Female plants with *many* secondary male flowers	114
Female plants with *few* secondary male flowers	65
Female plants with *very few* secondary male flowers	49
TOTAL	228

This is again borne out by the fact that out of 25 reversals brought about by artificial means as shown in Table V there were 23 male plants and only two female plants which developed flowers of the opposite sex after treatment.

The question arises as to why the number of male plants bearing female flowers is greater than that of the female plants producing male flowers. The explanation is not far to seek. The case of prothalli of ferns and equisetum suggests that the male organs are produced by an individual early in its development and are inhibited by a more fully developed body, while the female organs are developed only by a relatively mature body. In the case of hemp we assume that at the period when both the sex-determiners are free to express themselves most of the male plants are completely mature and are thus favourable for the production of female flowers, and that the number of immature female plants, at this stage which are suitable for the production of male flowers, is comparatively small. This accounts for the greater proportion of male plants bearing female flowers to the female plants bearing male flowers.

The fact that the majority of these male plants bear only a *very few* secondary female flowers and the majority of female plants bear *many* secondary male flowers can be explained on the ground that the female plants are more vigorous and can express the opposite sexual state without difficulty, while the comparatively less vigorous male plants which have already exhausted themselves hardly possess the energy required for the production of many female flowers.

Effect of pollination with fresh and stale pollen.

Cieselsky[1] in 1878 claimed that hemp pollinated with fresh pollen produced a great preponderance of staminate plants, while pollination with old pollen gave a preponderance of carpellate plants. He extended his investigations to animals and experimented with numerous rabbits, dogs, horses, and cattle and obtained similar results. He believed that the sex of the progeny was governed by the conditions of fecundation and the law discovered by him applied to all living beings, whether plants, animals or man. In dioecious plants fresh pollen produced male seeds while stale pollen gave rise to female seeds. He believed that sex in animals was determined by the age of the spermatozoa at the time when they united with the ova.

Lilienfield[2] tested Cieselsky's claims but could not substantiate them as he obtained an average of 37·77 per cent. staminate and 62·27 per cent. carpellate plants in hemp with fresh pollen and 38·55 per cent. staminate and 61·45 per cent. carpellate plants with pollen 12 hours old. With pollen 30 hours old 45·14 per cent. male and 54·86 per cent. female plants were obtained, while pollen 36 hours old gave 40·25 per cent. male and 59·75 per cent. female plants. These numbers all come within the natural fluctuation of the sex-ratio of hemp. He therefore believed that the progressive increase in the proportion of male to female plants with increased age of pollen might be due to a difference in the vitality of the male and female determining pollen grains resulting in the elimination of the weaker group.

With these two contradictory views in the field it was thought necessary to repeat the experiment with the Indian hemp and observe how this behaved. In 1925-26 six plants were pollinated with fresh pollen and six other plants were pollinated with stale pollen. The following year a progeny of 217 plants was obtained from the seed of the former and of 234 plants from the latter. The sex-ratios obtained in each case were as follows :—

TABLE IV.

Showing the effect of fresh and stale pollen on the sex-ratios of hemp in 1926-27.

Treatment	Total number of plants	No. of plants in						Sex-ratios in					
		Preliminary census			Final census			Preliminary census			Final census		
		Males	Females	Monoecious	Males	Females	Monoecious	Males	Females	Monoecious	Males	Females	Monoecious
Parent plants pollinated with fresh pollen.	217	50	139	28	46	137	34	1	2·78	0·56	1	2·98	0·74
Parent plants pollinated with stale pollen.	234	53	138	43	44	132	58	1	2·6	0·81	1	3·0	1·32

[1] Cieselsky. Abstract taken from *Jour. Hokkaido Agr. College, Japan*, XII, Part 3.

[2] Lilienfield, F. Results of pollination of *Cannabis sativa* with pollen of different ages. *Biol. Zentralbl.* 41, 1921, 295-303.

These figures are almost identical and are within the limits of experimental error, and thus show that under conditions of this experiment there was no appreciable difference between the sex-ratios obtained in the progeny of plants pollinated with fresh and stale pollen respectively, and that the results,[1] therefore, do not support Cieselsky's conclusions.

Effect of mutilations and chemical treatments.

Pritchard[2] working on hemp showed that by inducing a disturbance in the plant's physiological equilibrium by the removal of flowers and vegetative parts and by the injection of chemical substances into the stem, a change of sex could be brought about.

His experiment was closely followed in the Botanical Section, Pusa, with certain necessary additions and alterations. A number of plants were differently treated each year and observations were made to see whether such plants reversed their sex. All plants so treated had one thing in common, *i.e.*, they had all their flowers, whether male or female, removed from time to time.

Mutilations. Some plants had their flowers removed and were not given any other treatment. Others had their flowers removed and had their

(1) tops bagged with manilla bags so as to diminish the intensity of light falling upon the newly developing buds ;
(2) apex cut ;
(3) major portion of the lower branches pruned off ;
(4) major portion of the upper branches pruned off ;
(5) major portion of the leaves of the plants removed.

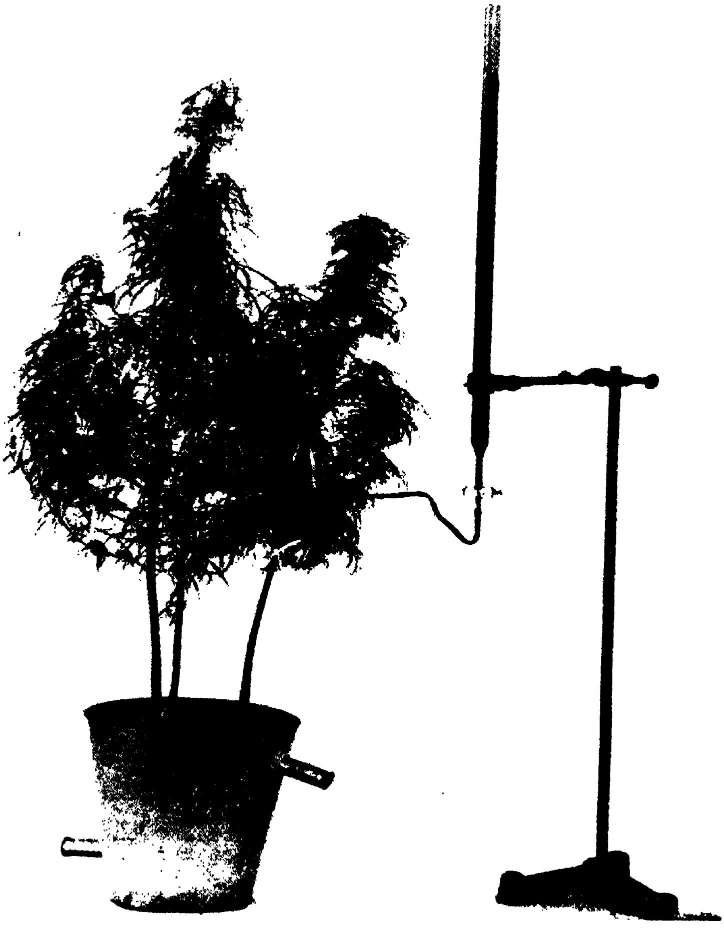
Chemical treatments. There were some plants in which the flowers were removed and which received one of the following chemicals as advocated by Pritchard :—

(1) Calcium nitrate, 1/10th per cent.
(2) Zinc sulphate, 1/10th per cent.
(3) Dextrose, 5 per cent.
(4) Maltose, 5 per cent.
(5) Peptone 1 per cent.
(6) Asparagin $\frac{1}{2}$ per cent.
(7) Potassium iodide 3 per cent., then $\frac{1}{2}$ per cent.
(8) Pyridin *n*/25.
(9) Acetic acid *n*/60.

Alteration of sex occurred under several different treatments, but whether these changes were due to the disturbance in the physiological equilibrium of the plants or to the natural tendency of developing flowers of the opposite sex is a debatable

[1] *Scientific Reports of the Agri. Res. Inst. Pusa*, 1926-27, p. 22.
[2] Pritchard, F. J. Change of sex in hemp. *Jour. Heredity*, VII, 1916, 325-329.

PLATE XXXII.



Hemp plant—method of injecting chemicals.

problem. Attempts were made to inject these chemical solutions into the stem by means of a hypodermic syringe, but this was not found practicable. Chemicals were, therefore, introduced by cutting a side branch in a vessel of water and slipping into it a rubber tubing attached to a burette containing the necessary solution. This is illustrated in Plate XXXII.

The chemical solution was sucked in with the rise of the transpiration current, but the rate of intake seemed to vary with different substances. As soon as the necessary amount of the solution was fed in, the burette was removed and the cut portion of the stem was given an application of vaseline. Of the chemical solutions tried maltose and asparagin proved successful, if this word could at all be used for the phenomenon observed.

The following Table gives the results obtained with this part of the experiment :—

TABLE V.

Showing the effect of mutilation and chemical treatment on hemp.

Year	Flowers removed			Flowers removed and top bagged			Flowers removed and apex cut			Flowers removed and lower branches pruned			Flowers removed and upper branches pruned			Flowers removed and leaves pruned			Flowers removed and chemicals introduced			No. of plants treated	No. of plants changed	
	♂	♀	Change if any	♂	♀	Change if any	♂	♀	Change if any	♂	♀	Change if any	♂	♀	Change if any	♂	♀	Change if any	♂	♀	Change if any		♂	♀
1925-26	4	4	0	4	4	1 ♂ plant	5	4	0	7	10	1 ♀ plant	..	..	..	4	3	1 ♂ plant	3	4	1♂ plant treated with maltose changed	56	3	1
1926-27	5	4	2 ♂ plants	6	6	0	5	5	0	8	8	2 ♂ plants	4	4	0	8	8	2 ♂ plant	16	16	1♂ plant treated with asparagin & 1♂ plant treated with maltose	103	8	0
1928-29	17	20	2 ♂ plants	..	..	..	122	120	0	83	81	7 ♂ plants	81	82	1 ♂ plant	..	..	..	23	20	0	649	10	0
1929-30	10	10	0	..	..	..	5	5	1 ♂ plant	5	5	0	5	5	1 ♂ plant and 1 ♀ plant	..	..	..	..	..	..	50	2	1
TOTAL	36	38	4 ♂ plants	10	10	1 ♂ plant	137	134	1 ♂ plant.	103	104	9♂ and 1 ♀ plants	90	91	2♂ and 1 ♀ plants	12	11	3 ♂ plants	42	40	3♂ plants	858	23	2

It may be observed that only a very few plants that were mutilated or chemically treated showed a reversal of sex, while a tendency towards monoeciousness was also shown by quite a high percentage of plants under natural conditions without any treatment whatsoever. Of the 25 cases of sex-reversals there were 23 male and only 2 female plants which developed flowers of the opposite sex. Pritchard had found in his experiment, however, that the females were more responsive to the stimulating effect of flower removal.

In 1925-26 only 7·1 per cent. plants out of 56 plants treated developed flowers of the opposite sex, while in a population of 1932 plants, 16·7 per cent. plants showed a natural tendency towards monoeciousness.[1]

In 1926-27[2] only 7·8 per cent. plants out of 103 mutilated or chemically treated reversed their sex, while under natural conditions and without any artificial treatment 21·7 per cent. of the total population of about 3,560 plants showed the very same condition.

In 1928-29 observations were made on the progeny of a culture which showed the least tendency towards monoeciousness and it was observed that 1·54 per cent. plants from a population of 649 plants mutilated or chemically treated reversed their sex in the sense Pritchard had shown, while 1·17 per cent. plants in the remaining 883 untreated plants again showed a tendency of developing flowers of the opposite sex when the normal flowering in those plants was almost over.

In 1929-30[3] only 50 plants were treated differently and 6 per cent. changed their sex, while of the remaining 922 plants kept untreated only 2·16 per cent. plants changed their sex normally.

This is summarised in the following table :—

TABLE VI.

Showing percentage of monoeciousness observed in treated and untreated plants of hemp.

Year	Nature of cultures	Mutilated or chemically treated			Untreated		
		No. of plants taken	No. of plants changed	Percentage	No. of plants taken	No. of plants changed naturally	Percentage
1925-26 .	Mixed .	56	4	7·1	1,932	322	16·7
1926-27 .	Mixed .	103	8	7·8	3,560	772	21·7
1928-29 .	Pure .	649	10	1·54	883	10	1·17
1929-30 .	Pure .	50	3	6·0	922	20	2·16

[1] Bose, R. D. Reversal of Sex in Hemp (Preliminary Report). Paper submitted for the Woodhouse Memorial Prize, Bihar, 1926.

[2] *Annual Report of the Imperial Economic Botanist, Pusa,* 1926-27, p. 22.

[3] *Annual Report of the Imperial Economic Botanist, Pusa,* 1929-30.

This Table shows that in the mixed cultures the percentage of monoeciousness in the untreated plants is greater than that in plants under treatment. In the pure culture H-17, however, which has a sex ratio of 1 : 1 with a very low percentage of monoecious plants, the percentage of monoeciousness in the treated plants is slightly greater than that in the untreated. It is obvious that it is of the utmost importance that experiments of this nature should be carried out on a culture such as H-17 in which the tendency towards natural monoeciousness is very low.

Some plants that were mutilated or otherwise treated have developed a few flowers of the opposite sex, and side by side the same phenomenon has been shown by a number of plants that received no treatment at all. It cannot be overlooked that the changes under these two conditions may be due to the same factors and that mutilation and other stimuli may have played no part in inducing sex changes. From the conditions of the experiment under report it may safely be maintained that the Indian variety of hemp is one in which there is a regular tendency towards monoeciousness, and that whatever few cases of alleged reversal of sex have occurred artificially may be nothing but instances of random natural monoeciousness. It may be believed with Darwin and Strasburger that both males and females are potential hermaphrodites.

It is quite possible that this material is different from that used by Schaffner and others in their experiments, as McPhee[1] has already reported that "the genetic balance in different hemp plants is such that a unit change in the environmental factors will produce more visible change in the sex of some than of others". All the same the importance of determining the amount of natural monoeciousness that a variety of unisexual plant under experiment for sex-study is capable of showing cannot be over-emphasized.

The thanks of the writer are due to Dr. F. J. F. Shaw, Imperial Economic Botanist, Pusa, for suggesting the piece of work and for his constant advice and guidance during the course of the investigation.

Summary

1. A sex-ratio of roughly 1 male : 3 females was observed for the first two years in a mixed *ganja*-producing type which had a high percentage of natural monoeciousness. When, however, a selection was made for a very low per cent. of natural monoeciousness, the sex-ratio in the following years came down to approximately 1 male : 1 female.

2. More male than female plants have a tendency of forming secondary flowers of the opposite sex. The majority of such male plants develop only a very few female flowers but the majority of the female plants produce many secondary male flowers.

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[1] McPhee, H. C. The influence of environment on sex in hemp. *Jour. Agr. Res.* XXVIII, 1924, 1079.

3. There appears to be no appreciable difference between the sex-ratios obtained in the progeny of plants pollinated with fresh and stale pollen respectively.

4. There seems to be a natural tendency in some plants of the Indian hemp to develop flowers of the opposite sex after the completion of their normal flowering. It is believed that reversal of sex brought about by mutilations and chemical treatments are but random examples of monoeciousness.

A PRELIMINARY NOTE ON THE WHITE-FLY OF COTTONS IN THE PUNJAB.

BY

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Historical.

The history of the White-fly (Aleurodidae) of cotton is very obscure. Mr. Roberts (1929) states :—

> " The Pusa experts inform us that, apart from some reference to cotton in China in 1805*, no mention of this insect has been made as a serious pest of cotton."

Messrs. Misra and Lamba (1929) hold that a White-fly, presumably the same which they have now named *Bemisia gossypiperda*, was noticed on cottons in Bihar as early as 1905, and " since then it has been present on cotton at Pusa, but not to any large extent so as to be considered as a pest ". Lefroy does not mention this White-fly in any of his contributions to Indian Entomology, not even in his publications dealing specifically with the insect pests of cotton (1906, 1908, 1909). Bainbrigge Fletcher (1917, 1920, 1921) does not include any White-fly of cotton among Indian crop-pests. Mr. Misra (1921) himself does not include the White-fly of cotton in his contribution " Some Indian Economic Aleurodidae".

As stated by Messrs. Misra and Lamba (1929), the White-fly was noticed in the Punjab, in 1915, by the Economic Botanist to Government, Punjab. The specimens obtained from cotton leaves were sent to Pusa for identification, and were identified as *A. gossypii.* Precise information regarding the ' status ' of this insect is not given.† The mere fact, however, that the White-fly was noticed on cottons in the Punjab in 1915 is very significant.

Recently Mr. Roberts (July, 1930) has attributed the failure of 3F (American variety) in 1913 to a White-fly. He says :—

> " The season proved disastrous to 3F owing to a severe attack of what was then termed ' Jassid '—probably now we should call it ' White-fly'."

A report of a widespread attack of the White-fly on cottons was received in August 1922, from the Montgomery District, and by actual observation at the spot the

* The date requires confirmation.

† Office files of the Economic Botanist to Government, Punjab.

identity of the pest was determined. Since then occasional reports had been received, but it was not till 1925 that the pest had increased so greatly as to demand attention.

It may be mentioned that the word 'Tela' is used for all sucking insects which produce honey-dew, and in addition to the White-fly the cottons are attacked by a Jassid and an Aphid which secrete this substance.*

INVESTIGATIONS IN THE PUNJAB.

Casual observations have been made on the White-fly of cottons since 1922, but definite investigations were started by the Entomological Section of the Department of Agriculture, Punjab, from the beginning of July 1928, and a special Assistant put in charge of this enquiry. The Indian Central Cotton Committee sanctioned one senior scholarship for the study of the Cotton White-fly at Khanewal, and Mr. Kidar Nath Trehan, the Assistant in the Entomological Section in charge of the White-fly investigation, was awarded this scholarship and was posted at Khanewal from the beginning of June 1929.

The observations recorded below are not complete yet, and would not have been published were it not for the fact that some of the statements contained in Mr. Roberts' contributions (1929, 1930) and Messrs. Misra and Lamba's account (1929) require a closer examination.

It is felt that a correct diagnosis of a disease is the first sure step in combating it, and that a plausible explanation is not always a correct one. A hasty conclusion may do incalculable harm in diverting the course of investigations into unproductive channels. Thus no apologies are needed for what follows.

DESCRIPTION.

The Cotton White-fly has been named *Bemisia gossypiperda* by Messrs. Misra and Lamba (1929), and they have described all the different stages of this insect and illustrated their description by diagrams and a coloured plate. In general the description may be accepted as correct but unfortunately there are certain serious mistakes which detract from its value. It is not intended to provide another description in this contribution but it is necessary that the more serious discrepancies and inaccuracies be recorded. The statement that 'the adults are..........with.. ....a pair of wings............' is evidently a misprint, and the diagrams and description of the adult make the point quite clear. At the end of the description of the second instar nymph the following statement appears : "antennae absent." This extraordinary statement is certainly not based on facts. From the descriptions and the diagrams it appears that these investigators are under the impression that the antennae are absent even in the third instar nymph and the pupa, as these organs are not described and are not shown in the diagrams. There is not the slightest

* Recently Kirkpatrick (1930) has stated that an unidentified species of Aleurodidae transmits leaf-crinkle of cotton in the Gezira area, Sudan. (See Bibliography.)

doubt that the antennae are present and have a characteristic form in each of the four immature stages. In the first stage nymph they are slender and 0·065 mm. in length; in the second stage nymph they are shorter—0·0216 mm. in length—and lie under the body projecting backwards; in the third stage nymphs they are bent and are roughly hook-shaped and 0·021 mm. long; in the pupa they are short and stumpy and end in a spine-like structure and the length is 0·057 mm. The antennae of the Aleurodidae have been described previously by other investigators and the description given above confirms the previously recorded facts.

Another important feature which has not been made out is the great variation in the form and number of 'dorsal spines,' particularly in the pupal stage. Pupae are met with possessing a full complement of eight pairs of well-developed 'dorsal spines' and a complete series down to the condition when all the 'dorsal spines' have disappeared.

Life-history.

The life-history of the cotton White-fly has been studied both at Lyallpur and Khanewal. The eggs are, normally, laid on the under surface of leaves, inserted into the tissue by short pedicles. It is only rarely that in cases of very severe infestations, or in captivity, a few eggs are laid on the upper surface of leaves. The eggs are mostly deposited on the top and middle leaves of a plant.

A virgin female laid 71 eggs in 14 days, and, so far, this is the highest record of egg-laying obtained in captivity.

The duration of the egg stage varies with temperature and on an average occupies about four to five days from May to October. It is considerably prolonged during the cooler parts of the year and the eggs laid during late November take 13 days to hatch, and those laid during the first week of December hatch after 31 days. During February and March the egg stage occupies 13 to 17 days, and by the beginning of April the period of incubation drops down to seven days.

The nymphs when newly hatched move about for sometime and then fix themselves, ordinarily on the underside of leaves and remain fixed for the rest of their nymphal life. There are 4 nymphal instars, the fourth instar being designated the pupa.

The duration of the nymphal instars varies from 9 to 84 days according to the season, temperature being the main controlling factor.

Duration of the life-cycles.—From the beginning of April to the end of September a complete life-cycle may occupy from 14 to 27 days; in October-November 36 days; from November to February 92 to 107 days. In March this duration drops down to 30 days or so. It has been observed that the nymphal stages are influenced most, and are prolonged during the cooler part of the year (see Statement I).

The pupal period extends from two to eight days, the shortest period being during the summer months.

STATEMENT I.

Showing the duration of life-cycle during 1928-29.

(A few representative life-cycles selected from a large number.)

Date of egg-laying	Date of hatching	Date of pupa formation	Date of emergence	No. of days	Remarks
10th Aug. 1928	14th Aug. 1928	27th Aug. 1928	29th Aug. 1928	19	
20th Sept. 1928	24th Sept. 1928	7th Oct. 1928	9-11th Oct. 1928	19, 21	
26th Sept. 1928	1st Oct. 1928	20th Oct. 1928	23rd Oct. 1928	27	
7th Oct. 1928	12th Oct. 1928	..	4-6 Nov. 1928	28, 29, 30	
7th Nov. 1928	17-18th Nov. 1928	30th Jan. 1929	7th Feb. 1929	92 *	
7th Nov. 1928	22nd Nov. 1928	9th Feb. 1929	22nd Feb. 1929	107 *	*There was a single generation from November to February. The adults which emerged all were females and laid eggs parthenogenetically.
22nd Feb. 1929	9th March 1929	..	26th March 1929	32	
2nd March 1929	15th March 1929	..	1st April 1929	30	
3rd April 1929	11th April 1929	..	24th April 1929	21	
27th April 1929	1st May 1929	..	14-15th May 1929	17, 18	
19th June 1929	23-24th June 1929	5-6th July 1929	8-10 July 1929	19, 21	
13th July 1929	17th July 1929	..	5-4th Aug. 1929	16, 17	
23rd July 1929	27th July 1929	5th Aug. 1929	7-8th Aug. 1929	15, 16	
6th Aug. 1929	9th Aug. 1929	..	20-21st Aug. 1929	14, 15	
26th Oct. 1929	8th Nov. 1929	..	15th Dec. 1929	50	

The adults are short-lived and may not survive longer than a couple of days during the hot summer months but, in captivity, they have been observed to survive from 13 to 24 days during October and November. When there is a wind blowing they are very reluctant to move but on warm still days they may be seen flying about in large numbers.

The number of generations in a year.—The progeny of a single female has been bred in captivity continuously for six generations starting from about the end of June to the end of October :—

On 28th June 1929 adults were captured from the field and sleeved ; eggs were laid and nymphs developed.

On 14-17th July 1929, after 16-19 days, the adults emerged and were sleeved again ; eggs were laid on 19th July 1929.

On 4-9th August 1929, after 16-20 days, the adults emerged and oviposited on 18th August 1929.

On 27-28th August 1929, after 17-18 days, the adults emerged and oviposited on 28-29th August 1929.

On 15-17th September 1929, after 18-19 days, the adults emerged and oviposited on 16-17th September 1929.

On 4-5th October 1929, after 18 days, the adults emerged and oviposited on 5th October 1929.

On 26-28th October 1929 the adults emerged after 21-23 days.

It is thus estimated that there may be about 10 generations during the course of a year. The broods, however, overlap considerably.

Parthenogenesis. Parthenogenesis has been observed, the progeny consisting of males only. It has also been noticed that after winter the number of females far surpasses that of males, and many of the females lay eggs which develop parthenogenetically.

SEASONAL-HISTORY.

The seasonal activities of the pest have been studied both at Lyallpur and Khanewal. There do not appear to be any regular broods of this insect as practically all the stages are met with throughout the year.

During the cotton season the pest reproduces quite freely on the cotton crop, and as soon as the plants appear the pest appears on them. It continues to increase in numbers and reaches its maximum strength in July-September. At the approach of winter, *i.e.*, about the end of September, the intensity of attack on cotton diminishes, and during winter the pest migrates to various weeds, cultivated plants and trees that are found in and around the fields and which serve as alternative hosts.

It was observed during 1928 that even intense cold (frost) did not kill the pest outright. The adults were no doubt killed, but the nymphs survived.

ALTERNATIVE FOOD-PLANTS.

B. gossypiperda is polyphagous and feeds on more than three dozen different plants belonging to a number of different families. To none of these plants it causes any direct damage which is visible externally. Experiments by cross-inoculation have been performed to definitely test the suitability of different food-plants for the propagation of this species.

THE NUMBER OF WHITE-FLY ADULTS ON A SINGLE COTTON PLANT.

Observations were started at the end of August 1929 to find out the total number of White-fly adults present on a single plant. For this purpose a white sheet was spread under a plant which was then enclosed in an air-tight oil-cloth box. The plant was then fumigated with hydrocyanic acid gas. The adult White-flies which

had dropped on the sheet were collected and counted. The following statement gives the result of these counts :—

Date	Time of observation	Average number of adults per plant
August 29th	7-30 A.M.	86
„ 29th	4-30 P.M.	146
„ 30th	10-30 A.M.	142
September 2nd	10-30 A.M.	205
„ 3rd	5-30 P.M.	229
„ 6th	5-0 P.M.	213
„ 11th	5-0 P.M.	106
„ 13th	4-30 P.M.	85
„ 16th	9-30 P.M.	41
„ 22nd	4-30 P.M.	57
„ 23rd	7-30 A.M.	134
„ 24th	8-30 A.M.	94
„ 25th	5-0 P.M.	31
October 1st	11-30 P.M.	61
„ 17th	10-0 A.M.	11
„ 24th	10-0 P.M.	17

It would be seen from the above that the adults were present in the largest numbers in the beginning of September, and that in October their numbers had fallen rapidly.

Attempts were also made to obtain some idea regarding the total of all the immature stages present on a plant at one time. All the leaves on a plant were removed and their area determined. The number of eggs, nymphs and pupae was counted. It was found that during the last week of September there were 60 nymphs and pupae per square inch of the area ; about the middle of October the number had dropped down to 1·6 per square inch. This method of estimating the number of insects on a plant is very cumbersome and the technique of making a census of the pest is being evolved.

THE INCIDENCE OF ATTACK ON THE DIFFERENT VARIETIES OF COTTON.

Messrs. Misra and Lamba (1929) state that the White-fly is " present more on the broad-leaved varieties of cotton than the short-leaved ones". Mr. Roberts

(1929) says—" The White-fly attacks both *Desi* and American, the latter to a much more serious extent than the former ". He also states—" The attack is always worse on the 4 F crop and is much less on a crop like 289 F ". This aspect of the problem is of considerable importance because if the White-fly continues to be a serious pest of cotton, then the evident line of improvement will be the development of the resistant varieties. The incidence of attack on the different varieties of cottons was determined by actual counts of the number of eggs, nymphs, pupae and pupal cases present. For each observation three cotton plants were taken from the same field, and from each plant one top leaf, one middle leaf and one lower leaf were taken, and the insects present within a circle an inch in diameter were counted from each of the nine leaves.

The varieties of cotton selected were : 289 F and 4 F to represent the common American types and *Mollisoni* and *Sanguineum* to represent the *Desi* types. All the four varieties were sown side by side in the same plot on 10th June 1929, and observations were started on 6th July 1929, and carried on to 17th December, 1929. The attached statement gives the details of the observations made. In this statement the numbers of eggs, nymphs, pupae and pupal cases have been taken together. The variations indicate the difficulties of making accurate census of insect populations.

From the figures available it appears that, on the whole, during July the attack was severest on *Mollisoni* and least on 289 F ; during August 289 F was leading, followed by *Mollisoni* and 4 F and *Sanguineum* showed the least attack ; during September the attack remained the highest on 289 F and 4 F followed it very closely,

STATEMENT II.

Comparative infestation of B. gossypiperda on different varieties of cotton.

Date of examination	The total number of immature stages and pupal cases over an area $9 \times \pi \times \frac{1}{(2)^2}$ square inches			
Year 1929	289 F	4 F	Mollisoni	Sanguineum
6th July	15	45	249	76
10th July	25	65	362	634
13th July	131	124	266	283
18th July	146	702	423	1,114
24th July	33	1,292	1,381	101
29th July	707	588	591	260
5th August	88	573	2,930	200
13th August	2,578	1,379	1,120	201

STATEMENT II—*contd.*

Comparative infestation of B. gossypiperda on different varieties of cotton—contd.

Date of examination	The total number of immature stages and pupal cases over an area $9 \times \pi \times \frac{1}{(2)^2}$ square inches			
Year 1929	289 F	4 F	Mollisoni	Sanguineum
19th August	2,091	1,337	1,208	938
25th August	2,340	1,337	1,265	1,089
4 h September	2,375	1,370	591	233
10th September	1,082	774	405	162
17th September	612	451	471	112
23rd September	559	2,042	352	201
27th September	1,976	1,413	780	396
4th October	240	492	79	87
9th October	1,338	578	517	392
16th October	1,495	1,073	424	391
22nd October	641	541	239	394
27th October	758	676	355	302
6th November	1,114	733	267	432
10th November	1,007	623	439	285
24th November	386	313	172	128
10th December	238	180	65	76
17th December	284	128	568	556

and the *Desi* varieties showed a great reduction in the severity of infestation. During October-November the attack was much reduced but comparative infestation followed the same order. During December, however, the *Desis* led once again with higher infestation.

From these facts it appears that during 1929, throughout the season, *Sanguineum* was the least attacked of all the four varieties. Up to the end of August *Mollisoni* came quite close to the American varieties, but from September onward the attack was much reduced on this variety.

These observations do not support Mr. Roberts' (1929) statement " The attack is always worse on the 4 F crop and is comparatively much less on a crop like 289 F ".

THE NATURE OF INJURY.

Like all phytophagous sucking insects the Aleurodidae obtain their food by piercing the plant tissues with their long stylet-like mouth-parts and sucking the plant juices. Like many of the sucking insects the White-fly excretes honey-dew, which falling on the leaves and branches below covers them with a sugary material on which a black mould develops. In cases of severe infestations this mould forms a thick coating on the upper surface of leaves and gives a black look to the entire crop. The mould may also appear on the lower surface of the leaves.

The injury caused by a sucking insect may be the result of : (1) a simple mechanical laceration of the plant tissues during the insertion or withdrawal of the stylets ; (2) a constant removal of the plant juice, thus depriving the plant cells of sap and food material ; (3) an injection of the salivary secretion into the plant tissue which may kill the surrounding tissue, and bring about cork-formation, spotting, unequal growth, etc., etc., leading to curling or any other deformation or even rapid defoliation, death of entire shoots, or other changes not visible to the eye may be produced ; (4) an injection of pathogenic organisms into the plant tissue or passive introduction of these organisms into the wounds made ; (5) the honey-dew secreted by the pest falling on the leaves interfering with respiration and transpiration, particularly when a large number of stomata are also situated on the upper surface of the leaves as is the case with the cotton plant, or the black mould developing on the upper surface of the leaves may interfere very materially with photo-synthetic activities of the plant.

The White-fly of cotton does not appear to cause any direct, visible damage to the leaf mechanically, nor does it produce any cork-formation, spotting, curling or any other deformation. The leaves badly infested do not drop off. So far the question of the introduction of any pathogenic organism has not been studied, but the abundance of White-flies and absence of corresponding abundance of any special damage by a pathogenic organism excludes this possibility.* It, therefore, seems probable that this insect causes damage to the plant (1) by sucking plant juices and lowering the vitality of the plant, and (2) by covering the leaves with honey-dew on which black mould grows, which interferes with the normal functioning of the leaves.

In the early stages the White-fly, even when present in very large numbers, does not produce any external symptom of attack, except that the honey-dew secreted by the nymphs falls on the leaves below and imparts them an oily appearance and stickiness. On this sugary matter black mould develops and an infested field may look blackish in colour with only the top leaves green. The attacked leaves, however, attain their normal size. Vegetative growth of the infested plants does not appear to be materially affected. In fact it has been noticed again and again that cotton plants with thick luxuriant growth harbour relatively a much larger number of the White-fly than the plants in poor condition.

* According to Kirkpatrick (1930) a White-fly transmits 'leaf-crinkle' of cotton in the Gezira area, Sudan. In the Punjab, *B. gossypiperda* does not produce directly or indirectly any malformation of the attacked leaves. *Empoasca devastance* (Jassidae) causes curling or wrinkling or crinkling of leaves, the attacked portions turning red and then drying.

To investigate the nature and extent of damage the following experiments were conducted at Khanewal, in all cases utilizing 289 F plants.

Experiment No. 1. In an infested field three cotton plants were enclosed on 16th June 1929 in a muslin cage, and, in order to increase the degree of infestation and maintain it at a high level, large numbers of adult White-flies were regularly introduced. The plants were very highly infested, almost all the leaves were covered over with black mould, yet the plants continued to grow and branch. The leaves were, however, drooping, only one plant produced five floral buds up to the end of December. The leaves neither turned yellow nor red, nor was there any extra defoliation. To all appearance the plants looked fairly healthy except that the leaves were rather flaccid.

Experiment No. 2. The above experiment was repeated, except that only two plants were enclosed in a muslin cage on 18th August 1929. The plants were heavily infested, but continued to grow. There was no change in the colour of leaves and no special defoliation. On the two plants 136 floral buds appeared and of these 128 (*i.e.*, 94 per cent.) dropped.

Experiment No. 3. On 8th July 1929 two plants in the same field as above were enclosed in a muslin cage. The infestation was allowed to continue, *i.e.*, the White-flies were neither removed nor introduced. These two plants produced 601 floral buds, 397 (*i.e.*, 66 per cent.) were shed and of the remainder less than 60 per cent. opened properly.

Experiment No. 4. On 28th June 1929 two plants were enclosed in a muslin cage. They were thrice sprayed with rosin compound on 28th June 1929, 10th July 1929 and 23rd August 1929, and further any adults found were hand-picked. Thus the plants were kept practically free of infestation. These two plants produced 537 floral buds, of which 320 shed (*i.e.*, 60 per cent.) and more than 90 per cent. of the remainder opened properly.

Experiment No. 5. The above experiment was repeated, the plants were sprayed on 14th August 1929 and caged the same day. The plants were given two more sprayings, and the adults appearing afterwards were hand-picked. These two plants produced 287 floral buds, of which 189 were shed (65 per cent.) and over 90 per cent. bolls opened properly.

These experiments, far too few to draw any conclusion from, are being repeated this season. It appears that in cages even very high infestation does not lead to the reddening of leaves or premature defoliation. It, however, seems probable that the reproductive function of the plants is interfered with and the influence of a heavy infestation of White-fly is to deter the formation of flowers and bolls and encourage the shedding of those formed. It may also influence proper opening, but shedding as well as bad opening may be brought about, as has been very often noticed, by the poor condition of the cotton plant produced through other causes.

Our experience of the White-fly of citrus shows us that these insects do not kill either the leaves or shoots although they may reduce fruiting considerably. We

are supported in our views by other investigators including Mr. Misra. It will be interesting to compare the condition produced by *B. gossypiperda* on cotton with that produced by the citrus White-flies on citrus. Mr. Misra (1921) states as follows :—

"During 1910 the mealy wing (*Aleurocanthus spiniferus*, Quaint.) was very abundant on a large number of *Citrus* spp. plants in the Botanical Area at Pusa. On the 28th July a large number of Sylhet orange plants were swarming with the Aleurodidae in every stage of development, and so profuse was the exudation of the honey-dew and the subsequent development of *Capnodium* sp. on the leaves that they looked black from a distance. *But for all this the plants did not seem to be any way the worse. They seemed to be flowering and fruiting like others which were not so badly affected and which were situated at a distance from the former.*" The sentences in italics are noteworthy.

According to Berger (1910), "Badly infested citrus trees usually bear but a small amount of fruit, and what is borne is insipid and covered with sooty mould". This is what we find in the Punjab.

Morril and Back's observations on the citrus White-fly in Florida, where it is considered a very serious pest, are similar. They state :—

"The direct injury by the citrus-fly may be included under two main heads : (1) injury by removal of sap, and (2) injury from fungus growth known as sooty mould (*Meliola*).................... The amount of sap extracted by the insects is not generally considered an item of great importance compared with the injury from sooty mould. While the extraction of sap by itself probably would not cause sufficient injury to make the White-fly rank as an important citrus pest, it is doubtless of considerable importance when combined with the lowered assimilative powers of the foliage due to the sooty mould.......... It has been estimated that the loss of sap per day amounts to about one-half of a pound for 1,000,000 larvae and pupae.......... Sooty mould is the principal evidence of White-fly injury, and is the most important element of damage, affecting both the foliage and fruit.... .... The effect of dark, compact mycelial membranes of the sooty mould covering the leaves would be to almost wholly check the process of phyto-syntax in the orange tree. The stomata .... are also to some extent closed by the sooty mould, and in this way the passage of gas is more or less hindered............... In plants where stomata are on the upper surface of the leaf also, the damage resulting from the obstruction of the passage of gases would probably be considerably greater."

Thus one would be justified in concluding that the White-flies of cotton and citrus do not produce any external sign of injury, such as curling, spotting, withering or defoliation. They secrete honey-dew which falling on the leaves makes them sticky and shiny, and later on black mould grows on this material. This interferes with photo-synthesis, and in case of cotton where a large number of stomata are also situated on the upper surface it may seriously interfere with respiration and transpiration. In case of citrus it is commonly seen that two or more broods of this pest may develop on the same leaf and yet the leaf may not show any external sign of injury. The

citrus are comparatively slow growing trees, and fresh shoots usually appear twice a year, and it is only the new leaves that are infested. Thus the leaves attacked remain the source of food-supply of the plant for a considerable period. In the case of cotton the infestation has to be started every year, and, naturally, from a small beginning the pest has to multiply, while in the case of citrus the infestation continues year after year. The cotton is a very much quicker growing plant as compared to citrus, as, within a short period of four months or so, the plant attains its maximum growth. Thus there is a competition between the plant and the pest. Except in very rare cases the plant has the advantage, and the leaf-area unaffected is much larger than the area affected. Thus the plant is able to withstand the drain.

The real nature of injury caused by the Aleurodidae is not understood. This, however, is certain that the vegetative growth is not affected materially by an 'ordinary' infestation in fields or heavy infestation under cages. It is likely that this pest accentuates the effects of drought, lack of fertility of soil, etc. (Morril and Back). A comparison with the condition provided by the citrus White-fly and the cage experiments cited above, indicates that rthe pest interferes with the reproductive function of the plants—flowers are not poduced, and bolls that set drop off.

SPRAYING.

Although it is too early to give a definite opinion yet, the results of spraying appear to be encouraging, as is evident from Statement III.

STATEMENT III.

Area	Treatment	Yield		
		Md.	Sr.	Ch.
¼ acre	Sprayed twice	2	34	13
¼ acre	Control	2	15	8
¼ acre	Sprayed once	2	9	2
¼ acre	Sprayed twice	2	30	12
¼ acre	Control	1	17	2

At any rate these experiments show that the White-fly is a pest, causing severe losses to the cotton crop.

THE FAILURES OF THE AMERICAN COTTON CROPS IN THE PUNJAB AND THEIR CAUSES.

It is mostly in the canal colonies that the American varieties are grown, and out of a total area of 974,370 acres under these varieties in 1928-29, 971,315 acres were

grown under canal irrigation. The high yields combined with higher prices were making these varieties quite attractive. Unfortunately, however, during the past 10 years or so there have been five more or less serious failures. The first of these was in 1919, which was fairly general, this was followed by a partial failure in 1921. The next four crops were very satisfactory and then came in another general failure in 1926, followed by a partial failure in 1927 and 1928. The 1929 crop, although not quite normal, was considered fairly satisfactory.

The condition of the crop during the years of failure have been briefly stated by Mr. Milne (1922) thus :—

" In the month of Asu (15th September to 15th October) farmers complained that American cotton plants especially dropped many of their flowers and young bolls ; that in Americans the first pickings were very poor and late, the bolls did not open properly, the lint was trash, seeds were not properly developed and the leaves turned yellow and red. They stated that in *Desi* cottons the opening of the bolls and qualities of the lint and seed were much less affected than in the case of Americans, and that the *Desi* cotton leaves did not turn so conspicuously yellow and red, but that losses even in the case of some *Desi* fields were ruinous." To this may be added excessive premature defoliation.

Mr. Roberts (1929) describes the condition ot the crop during the years of failure thus :—

" The plants generally fruit copiously, but the colour of the plant is somewhat pale and growth stunted. However, up to the end of September (or the first week or 10 days in October when crop is late as in the present season) there is little apparent damage. Then all at once bolls begin to open prematurely, and the unopened bolls will be found to be soft to the touch. It is not infrequent to see a plant with 15 or 20 bolls of which no more than 2 to 5 open normally and give fully developed lint and cotton-seed. In these prematurely opened bolls there is no seed at all, sometimes a half-developed seed. The fibre has no strength whatever, and in practice the pickers will refuse to pick these bolls, and they are left on the field and are useless."

From both these accounts it appears that the damage becomes apparent about the end of September or even after September. The main features of the failing crop are :—

(i) Leaves turn yellow and red (Mr. Milne) ;
(ii) there is considerable defoliation prematurely ;
(iii) flowers and young bolls drop off (Mr. Milne) ;
(iv) bolls do not open properly ;
(v) lint is trash ;
(vi) seeds are not properly developed.
(Mr. Milne and Mr. Roberts.)

It may be stated that Mr. Roberts maintains that fruiting is copious.

Mr. Milne and Mr. Trought, as pointed out by Mr. Roberts (1929), although differing in their views, hold certain environmental factors responsible for this abnormal condition of the cotton crop.

Mr. Roger Thomas (Roberts, 1929) has put forward the theory that the White-fly of cotton is the main cause of the failures of the American cottons in the Punjab. Mr. Roberts (1929, 1930) and Messrs. Misra and Lamba also favour this view (1929). We shall critically examine this theory now.

The White-fly and the cotton failures.

Mr. Roberts (1929) has advanced certain definite arguments in support of the theory that *B. gossypiperda* is the *main* cause of the failure of the American cotton crop in the Punjab. His first and possibly the most important argument is :—

> " The ' White-fly ' attacks the plant by sucking the juice and as many as 250 insects per square inch of leaf may sometimes be counted. The life-cycle will take only 20 days in summer, which would enable the insect to rear four or five broods from May till the end of September. Such weakening of the vitality of the plant as would be brought about by the attack of the insect would account for the failure of the plant to ripen its bolls."

The facts stated are quite correct, but the conclusions drawn require further examination. Before this is done it may be pointed out that the presence of 250 insects per square inch on certain severely infested leaves is no proof of the fact that all the leaves of an infested plant are equally badly infested simultaneously. The counts made show that on a severely infested plant, at the height of the attack, there may be at one time on an average 60 nymphs and pupae per square inch of the leaf surface.

Even the fact that there are four or five broods from May till the end of September does not necessarily mean that all the leaves will get infested equally severely and remain infested throughout the growing period of a plant.

The cotton plant grows very quickly and, within a short period of 12 or 16 weeks, it reaches its maximum growth and may have as many as 300 leaves. Thus new leaves appear in quick succession, and even at the time of the severest attack many of the leaves are free from infestation, and those infested, unless covered with mould, are likely to perform their functions fairly satisfactorily. It has been noticed that even in cases of severe infestation by the White-fly anabolism is in excess of catabolism. The proof of this is that the infested plants continue to grow. This is borne out by Mr. Roberts' (1929) observation '.............. up to the end of September there is a little apparent damage'. It may be argued that the plant is able to maintain its growth but is not able to store up sufficient food material for boll-formation and boll-ripening. The case of the 1929 crop shows that under favourable environmental conditions even plants most severely attacked by the White-fly are capable of producing a good crop. At the Agricultural Farm, Montgomery, it was noticed that the plants growing near the protective hedges were taller, and showed luxuriant growth, and at the same time had a heavier infestation of White-fly than plants in the middle of the field, which were stunted,

showed reddening of leaves and defoliation and were comparatively less heavily infested. This lends support to the above conclusion. Simple 'weakening of the vitality' through the action of the White-fly should show its effect in poor growth, defoliation and non-setting of bolls rather than in 'copious formation' of bad bolls, as Mr. Roberts maintains.

Mr. Roberts' second strong argument is :—

"It was observed, in 1926 in a general way and more accurately in 1927, that late sown crops gave much better yields than early sown..........the latest sown gave practically double the yield of the earliest sown, and this could be accounted for by the late sown escaping one or more cycles in the insect's life."

This argument is supported by actual figures of yield for 1927. Thus 289 F sown during the third week of April yielded on an average three mds. of cotton as against 6 mds. 8 srs. per acre for the same variety sown during the fourth week of May. Similarly 4 F sown during the second week of May gave 1 md. 5 srs. per acre against 3 mds. 4 srs. per acre obtained from fields sown during the second week of June. Once again *Mollisoni* sown during the first week of May yielded 5 mds. 1 sr. per acre as against 11 mds. 5 srs. per acre obtained from sowings during the second week of June (Roberts, 1929). Is this on account of the fact that the late sown escaped the attention of one or more broods of the White-fly as alleged by Mr. Roberts ? The argument advanced cuts both ways. It is quite evident that the total population of White-flies present during the third week of April is much smaller than that present during the second week of June. If a female lays only 50 eggs and the life-cycle is completed in 20 days, and if half of the progeny are females, then for every female present during the third week of April there should not be less than 15,000 females during the second week of June. And these females will be available for a concerted attack on the *germinating seedlings* of the late sown cotton. What chance for a seedling developing at a time when the pest is in its full strength !

The fact, however, remains that the late sown crops have given better yields than the early sown. For an explanation of this phenomenon we must, therefore, look to *some other cause*. In this connection reference may be made to Trought's work (1930).

We find from Mr. Roberts' statements that different varieties of cotton have behaved differently in so far as the yields are concerned inspite of the late sowing. Thus we find that 289 F sown during the fourth week of May gave 6 mds. 8 srs., against 3 mds. 4 srs. from 4 F, and 11 mds. 5 srs. from *Mollisoni* sown during the second week of June. We have seen that, as judged by the number of nymphs, present on leaves *Mollisoni* comes very near 4 F and 289 F in severity of infestation. Then why should it not suffer to the same extent ? It is interesting to note that the difference of yield between early and late sown American cottons are in the same proportion as between early and late sown *Desi* cottons (*Mollisoni*), and at the same time we are told by Mr. Roberts and Mr. Misra that the *Desis* are not so badly

affected by the White-flies as the Americans. It is not a case of resistance depending on escape from infestation, but a higher yield in spite of infestation. It is difficult to understand so precise and selective an effect by an insect which injures the plant by merely drawing away its juice.

It may, however, be argued that some varieties may harbour the pest, and yet may for some reason not suffer to the same extent or be capable of making good the loss. It is difficult to say if the *Desis* have any specific advantage over the Americans in this respect.

Mr. Roberts (1929) states that the application of ammonium sulphate improved the crop which looked much greener and showed more vigorous growth, and this evidently happened inspite of the White-fly. This means that if the vigour of the plant is maintained through fertilizers or by other means, then the evil influences of the pest can be checked. Thus on fertile, well-cultivated lands the White-fly would not be responsible for cotton failure. During years of failure, however, the ' disease ' is so widespread that some other more universal factor or factors must be operating and producing the abnormal condition of the crop.

Having discussed Mr. Roberts arguments, we now turn to other evidences. The American cottons failed in the Punjab during 1919 and 1921, and again during 1926, 1927 and 1928, and to be able to place definitely the responsibility for this failure on the White-fly one must be able to establish its presence as a ' pest ' not only during 1926 to 1928, but also during 1919 and 1921.

Those who hold that the White-fly is mainly responsible for the failure, do maintain that the White-fly was present as a serious pest in all those years during which the cotton failed although it escaped notice. Mr. Roberts (1929) states :—

> " In previous attack, the Agricultural Department and the Mycological Experts from Pusa and Lyallpur examined the crop generally from November onwards. As soon as the cold weather starts, the ' White-fly ' practically leaves the cotton crop............ Its absence during the period when investigations were in progress might easily result in the significance of the attack in July, August and September being missed."

In a recent article Mr. Roberts (1930) goes a stage further, and makes the following statement :—

> " The season (1913) proved disastrous to 3 F owing to a severe attack of what was then termed ' Jassid '—probably now we should call it ' White-fly'."

Investigations on the improvement of the cotton crop were started by Mr. Milne (formerly Economic Botanist to the Government, Punjab, now Director of Agriculture, Punjab) in 1907, and from the very beginning the importance of the entomological aspect of the problem was kept well in view, as is evident from the fact that the presence of the White-fly of cotton was discovered in 1915 (Misra and Lamba, 1929).

Observations on the pests of cottons were started in 1912, and a special Assistant trained at Pusa in entomology was detailed for this work from 1918. Special attention was paid to the entomological aspect of the cotton failures of 1919 and 1921, and it is definitely stated that no insect was responsible for the abnormal condition of the crop. The Assistants of the Economic Botanist to Government, Punjab, who made surveys of the cotton failure of 1919, and 1921 are definite on the point that the White-fly, which is so common now, was certainly not present in any large numbers in 1919 and 1921.

Mr. Milne knew of the existence of the White-fly of cotton in 1915, and it is extremely unlikely that an investigator of his thoroughness and experience failed to notice this insect when it was present in the form of a serious pest during 1919 and 1921. He certainly would have noticed this pest in his own experimental fields at Lyallpur, if nowhere else.

The Entomological workers in the Punjab have been familiar, for some considerable time, with the White-fly of sugarcane, citrus and castor, and it is highly improbable that the White-fly of cotton escaped their notice even when it was present as a pest so serious that it brought about widespread and general failure of the cotton crop. If this insect had existed as a serious pest, the fact would have been noticed and recorded.

The cultivators of the Punjab who are quite familiar with the 'tela' only complained of the 'sundi' (boll-worm) during 1919 and 1921 (Milne). Surely blackness of the leaves which is so prominent a character could not have escaped their notice.

Regarding Mr. Roberts' remark that during 1913 variety 3F really failed because of White-fly attack which was wrongly identified as Jassid, the following quotation from Mr. Roberts' report (1914) is worthy of notice :—

"......Variety 3 F, owing to its having suffered from Jassids in July and August, yielded poorly, and thus the results are not comparable. Besides 3 F the following American varieties are smooth-leaved and suffered from Jassids, *viz.*, 168 F and 179 F, and were discarded. Variety 280 F also suffered to some extent but is being given a further trial on account of the good quality of the lint. Type 4 F continued to do well."

How was it that 4 F, which, according to Mr. Roberts, is so susceptible to White-fly attacks now, withstood the attack of White-fly so well in 1913 ? There is hardly any reason to doubt that the insect referred to in the Departmental Report in 1913-14 was a Jassid. Moreover differences between the Jassidae and Aleurodidae in their general form, movements and types of damage caused, are so great that even a casual observer cannot help noticing them, and there is hardly any chance of the two being confused by trained scientists. Further during the same year Mr. M. M. Lal (1914) in his report mentions two Aleurodidae, one on date-palm and the other on citrus. Thus it is exceedingly unlikely that for the failure of 3 F in 1913 a Jassid was wrongly accused.

Conclusions.

There is not the slightest doubt that the White-fly is to be considered a serious pest of cottons, reducing yield through non-formation and dropping of bolls. At the same time it has to be admitted that very little is known as to the real nature of injury it causes. Experimental evidence is not complete. The question is : Was the White-fly responsible for bringing about the failure of the cotton crop in 1919, 1921 and again in 1926, 1927, 1928 ? It is premature to express any definite opinion, and I state my views under reservation. I admit that the White-fly does lower the vitality of the attacked plant, and interferes with the health of the plant, but ***under ordinary conditions*** it does not do it to such an extent as to bring about a total failure of the crop. Large numbers of leaves have been observed absolutely completely covered with the nymphal and pupal stages and yet quite green and showing no sign of yellowing or reddening.

In the beginning of the season the *Desi* cotton is attacked, and in some cases the attack is severer than on the Americans. Leaves turn black on account of the sooty mould, and yet the plants recover. In some fields, in spite of the heavy attack of White-flies, even the American varieties yield as well as in some of the fields unattacked.

The symptoms of the cotton failure make appearances during September-October. Is it likely that the plant which does not suffer when the attack is the heaviest and the plant at a young stage, *i.e.*, in July and August, begins to show the disease when the insect has subsided ? There is the possibility of accumulated effect but direct injury should show surer results, and these are absent.

As long as our enquiries are not complete it is not right for us to express any opinion one way or the other. That the White-fly is a serious pest of cotton, there cannot be two opinions about it, but it is highly doubtful if it is the *main* cause of the widespread failure of the cotton crop, particularly the American varieties. In 1929 the White-fly was very severe indeed, and yet the crop was fairly satisfactory except in the Lower Jhelum Canal where on account of canal closures the entire crop failed, showing the characteristic signs of the 'abnormal conditions'.

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FURTHER YIELD TRIALS WITH SOME PUSA BARLEYS.

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In the *rabi* season of the year 1928-29, three types of barley isolated at the Botanical Section, Pusa, were compared against a local mixed variety. The plots were 4′ × 4′ square arranged in a "chess-board" fashion. The yields obtained were reported[1], and the results analysed statistically by the application of Bessel's, Student's and Engledow and Yule's methods. All these methods pointed out the superiority of the three Pusa types over the local, and showed that B-4 (now numbered Type 21)[2] was the best. The results of a 'blank test' this season for determining the amount of soil heterogeneity in the same field on which these trials were conducted last year showed a fair amount of correlation between the adjacent plots. This was worked out by Harris' mothod which gave a coefficient of correlation of +0·38. It may be pointed out that the greater the coefficient of correlation the greater is the heterogeneity of the soil under trial. The analysis of results by Engledow and Yule's method or by that of "Student" corrects, to a certain extent, the presence of this universal factor of soil heterogeneity, and hence the conclusions drawn last year are not materially affected by the results of this test of soil heterogeneity.

In 1929-30, yield trials in strips were run with two types which had been used in the previous season together with two new types, and the local variety was discarded as its inferiority to the Pusa types had been definitely established by the previous season's trial. The strips were long and narrow and 4′ × 60′ in size, running north and south with an interspace of two feet and arranged in the form—

A B C D, B C D A, C D A B..................

and so on. The number of repetitions included were 10, making in all 40 strips. There were five lines to a strip drilled with equal weights of seed at a distance of

[1] Shaw, F. J. F.; and Bose, R. D. Yield trials with some Pusa Barleys. *Agri. Jour. India*, XXIV, 1929, 371-396.

[2] Bose, R. D. Studies in Indian Barleys. (1) Classification of types isolated at Pusa. *Indian Journal of Agricultural Science*, Vol. I, Pt. 1.

one foot apart. There was a fairly uniform stand of the crop in all strips. The after-cultivation consisted of three uniform hoeings. At harvest a border of two and a half feet at both ends of each strip was rejected. The outer rows and the three central rows of each strip were harvested, threshed and weighed separately. The weights of grain of the entire plot are shown in Table I.

TABLE I.

Weight of grain in decagrams.

Repetition	Type 21 A	Type 20 B	Type 12 C	Type 7 D
1	1,196	910	740	933
2	1,040	667	843	839
3	905	744	787	737
4	733	645	657	658
5	761	610	597	575
6	710	662	599	661
7	803	647	692	618
8	787	673	672	684
9	794	773	672	620
10	958	793	761	593
Mean	868·7	712·4	709·4	691·8

Worked out by Engledow and Yule's method[1], the Standard Error of the experiment was found to be $\pm 30 \cdot 2$, and Table II summarises the results obtained.

TABLE II.

Variety	Mean diff. from T. 21	Standard error of mean diff.	'Z'	Odds
Type 20	—156·3	±30·2	5·2	Overwhelming.
Type 12	—159·3		5·3	"
Type 7	—196·9		6·5	"

When 'Z' is more than 2·1 the differences are statistically significant.
When 'Z' is more than 4·1, the odds are more than 2,500 : 1, and so the odds are noted as overwhelming when 'Z' is greater than 4·1.

[1] Engledow, F. L.; and Udney Yule, G. The Principles and Practice of Yield Trials. *Empire Cotton Growing Review*, III, 1928, Nos. 2 and 3.

Thus Type 21 (B-4) stands out again this year as the heaviest yielding barley. The conclusions drawn last season with the chess-board trials were borne out this year by the strip trials, and Type 21 has proved the best of the four types tested, followed by Type 20 and Type 12, both of about the same value. Type 7 is the poorest.

Competition is a potent factor in all yield trials and the yields of adjoining plots are believed to be disturbed by the influence of the neighbouring plots in a number of ways, *viz.*, height, habit, maturity, etc. Again the response of different strains of a crop to differences in spacing may be diverse. To obtain an idea of this influence, the yields of only the central rows and those of all the rows were taken separately for calculating the standard error of the mean difference. Table III shows the comparative results obtained.

TABLE III.

Variety	Percentage of mean difference from T. 21		Percentage of standard error of mean difference		'Z'		Odds	
	All rows	Central rows	All rows	Central rows	All rows	Central rows	All rows	Central rows
Type 20 .	18·0	14·2	±4·04	±4·18	4·4	3·4	Overwhelming.	1600 : 1
Type 12 .	18·1	13·1			4·5	3·1	Do.	550 : 1
Type 7 .	22·0	18·0			5·0	4·3	Do.	Overwhelming.

It is interesting to note that the differences were all significant whether the yield of the central rows or that of the entire plot was taken into consideration, though Type 12 is second in rank in the former case and third when all the rows are considered. Type 21 seems to utilize the borders to a greater advantage than the other types. The percentage of yields of the outer rows to those of the central rows is,

the greatest in Type 21 amongst all the types compared. This is brought out in Table IV given below :—

TABLE IV.

Variety	Mean yield in gm.		Percentage of outer rows to central rows
	Central rows	Outer rows	
Type 21	4,415	4,272	96·7
Type 20	3,788	3,336	86·9
Type 12	3,847	3,247	84·4
Type 7	3,624	3,294	90·9

It may be added that Type 21 is found to be more resistant to leaf-stripe disease, is early maturing and has a stronger straw—characters in favour of Type 21 though secondary to considerations of yield. These good qualities of Type 21 are apparent in the results obtained with this barley outside Pusa. Yields of 2,755 lb. per acre at Shahjahanpur, U. P., and 2,214 lb. per acre at Benipur, in Bihar, promise well for the success of this type. The average outturn of the ordinary country barley, when grown as a single crop, is about 980—1,230 lb. per acre and rarely reaches over 1,600 lb. per acre. A quantity of seed of the high-yielding Type 21 will be available for distribution after next harvest, and indents for seed should reach the Imperial Economic Botanist, Pusa, before March 1931.

SUMMARY.

(1) A further yield trial with Pusa barleys in strips conducted in the Botanical Section, Pusa, confirmed the superiority of Type 21 over three other types compared against it.

(2) Seed of Type 21 is available for distribution.

SELECTED ARTICLE

OFFICIAL STANDARDS FOR ITALIAN RICE.

[By a decree dated the 20th January, 1930-VIII (Fascist), published in the "Official Gazette" No. 17 of 22nd January, 1930-VIII, the Italian Government have laid down revised official standards for home-grown rice, of which the following is the English translation. These new standards replace those published in the May (1930) No. of the *Agricultural Journal of India* (Vol. XXV, Pt. III, pp. 245-249).]

TYPES AND OFFICIAL DENOMINATIONS OF NATIONAL RICE PREPARED FOR EXPORT.

I. ITALIAN "CAROLINA" TYPES.

1. "Carolina Sublime Special."

A healthy rice, sound quality and fit for the market, obtained from the varieties "Bertone," "Allorio," and "Novella," good average of the year, of a high grade of purity and perfectly dry, first grade cleaning, thoroughly polished and free from yellow and amber grains.

Allowances :—10 per cent. red streaked grains, 3 per cent. big broken grains, 2 per cent. chalky grains, ½ per cent. pitted grains or with slight black streaks, 13½ per cent. moisture.

2. "Carolina Sublime."

A healthy rice, sound quality and fit for the market, obtained from the varieties "Allorio," "Novella," "Greppi," and "Tolmino-Dellarole," good average of the year, of a high grade of purity and perfectly dry, first grade cleaning, thoroughly polished and free from yellow and amber grains.

Allowances :—6 per cent. red streaked grains, 3 per cent. big broken grains, 2 per cent. chalky grains, ½ per cent. pitted grains or with slight black streaks, 13½ per cent. moisture.

3. "Carolina Diamond."

A healthy rice, sound quality and fit for the market, obtained from the variety P. 6, good average of the year, of a high grade of purity and perfectly dry, first grade cleaning, thoroughly polished and free from yellow and amber grains.

Allowances :—6 per cent. red streaked grains, 3 per cent. big broken grains, 3 per cent. chalky grains, ½ per cent. pitted grains or with slight black streaks, 13½ per cent. moisture.

4. "Carolina Vittoria."

A healthy rice, sound quality and fit for the market, obtained from the "Vittoria" variety, good average of the year, of a high grade of purity and perfectly dry, first grade cleaning, thoroughly polished and free from yellow and amber grains.

Allowances :—3 per cent. red streaked grains, 2 per cent. big broken grains, 2 per cent. chalky grains, ½ per cent. pitted grains or with slight black streaks, 13½ per cent. moisture.

II. ITALIAN "GIANT" TYPES.

1. "Giant extra polished."

A healthy rice, sound quality and fit for the market, obtained from the "Maratelli" variety, good average of the year, of a high grade of purity and perfectly dry, first grade cleaning, thoroughly polished and free from yellow and amber grains.

Allowances :—2 per cent. red streaked grains, 3 per cent. big broken grains, 3 per cent. chalky grains, ½ per cent. pitted grains or with slight black streaks, 14 per cent. moisture.

2. "Giant extra oiled."

A healthy rice, sound quality and fit for the market, obtained from the "Maratelli" variety, good average of the year, of a high grade of purity and perfectly dry, second grade cleaning, thoroughly oiled and free from yellow and amber grains.

Allowances :—2 per cent. red streaked grains, 3 per cent. big broken grains, 3 per cent. chalky grains, ½ per cent. pitted grains or with slight black streaks, 14½ per cent. moisture.

3. "Giant extra refined."

A healthy rice, sound quality and fit for the market, obtained from the "Maratelli" variety, good average of the year, of a high grade of purity and perfectly dry, first grade cleaning, free from yellow and amber grains.

Allowances :—2 per cent. red streaked grains, 3 per cent. big broken grains, 3 per cent. chalky grains, ½ per cent. pitted grains or with slight black streaks, 14 per cent. moisture.

III. ITALIAN "ORIGINAL" TYPES OF RICE.

1. "Superior Splendour" or "A. A. A."

A healthy rice, sound quality and fit for the market, obtained from the original Chinese variety or another similar variety, good average of the year, of light colour and perfectly dry, first grade cleaning, thoroughly polished and free from yellow and amber grains.

Allowances :—2 per cent. red streaked grains, 2 per cent. big broken grains, 2 per cent. chalky grains, ½ per cent. pitted grains, 13½ per cent. moisture.

2. "Splendour Extra Extra."

A healthy rice, sound quality and fit for the market, obtained from the original Chinese or another similar variety, good average of the year, of light colour and perfectly dry, first grade cleaning, thoroughly polished and free from yellow and amber grains.

Allowances :—2 per cent. red streaked grains, 7 per cent. big broken grains, 2½ per cent. chalky grains, ½ per cent. pitted grains or with slight black streaks, 13½ per cent. moisture.

3. "Splendour Extra" or "A. A."

A healthy rice, sound quality and fit for the market, obtained from the original Chinese or another similar variety, good average of the year, of light colour and perfectly dry, first grade cleaning, thoroughly polished and free from yellow and amber grains.

Allowances :—2 per cent. red streaked grains, 12 per cent. big broken grains, 2½ per cent. chalky grains, ½ per cent. pitted grains or with slight black streaks, 13½ per cent. moisture.

4. "Superior Oiled."

A healthy rice, sound quality and fit for the market, obtained from the original Chinese variety or another similar variety, good average of the year, of light colour and perfectly dry, first grade cleaning, thoroughly oiled and free from yellow and amber grains.

Allowances :—2 per cent. red streaked grains, 2 per cent. big broken grains, 2 per cent. chalky grains, ½ per cent. pitted grains or with slight black streaks, 13½ per cent. moisture.

5. "Extra Oiled."

A healthy rice, sound quality and fit for the market, obtained from the original Chinese or another similar variety, good average of the year, of light colour and perfectly dry, first grade cleaning, thoroughly oiled and free from yellow and amber grains.

Allowances :—2 per cent. red streaked grains, 12 per cent. big broken grains, 2½ per cent. chalky grains, ½ per cent. pitted grains or with slight black streaks, 13½ per cent. moisture.

6. "Superior Natural."

A healthy rice, sound quality and fit for the market, obtained from the original Chinese or another similar variety, good average of the year, of light colour and perfectly dry, first grade cleaning and free from yellow and amber grains.

Allowances :—2 per cent. red streaked grains, 2 per cent. big broken grains, 2 per cent. chalky grains, ½ per cent. pitted grains or with slight black streaks, 13½ per cent. moisture.

7. "Superior Splendour."

A healthy rice, sound quality and fit for the market, obtained from the original Chinese or another similar variety, good average of the year, slightly less light in colour, perfectly dry, second grade cleaning, highly polished and free from yellow grains.

Allowances :—3 per cent. red streaked grains, 2 per cent. big broken grains, 2½ per cent. chalky grains, 1 per cent. pitted grains or with slight black streaks, ½ per cent. amber grains, 14 per cent. moisture.

8. "Fine Splendour."

A healthy rice, sound quality and fit for the market, obtained from the original Chinese or another similar variety, good average of the year, slightly less light in colour, perfectly dry, second grade cleaning, highly polished and free from yellow grains.

Allowances :—3 per cent. red streaked grains, 12 per cent. big broken grains, 3 per cent. chalky grains, 1 per cent. pitted grains or with slight black streaks, ½ per cent. amber grains, 14 per cent. moisture.

9. "Superior Oiled."

A healthy rice, sound quality and fit for the market, obtained from the original Chinese or other similar varieties, good average of the year, slightly less light in colour, perfectly dry second grade cleaning, well-oiled and free from yellow grains.

Allowances :—3 per cent. red streaked grains, 2 per cent. big broken grains, 2½ per cent. chalky grains, 1 per cent. pitted grains or with slight black streaks, ½ per cent. amber grains, 14 per cent. moisture.

10. "Fine Oiled."

A healthy rice, sound quality and fit for the market, obtained from the original Chinese or other similar varieties, good average of the year, slightly less light in colour, perfectly dry, second grade cleaning, well-oiled and free from yellow grains.

Allowances :—3 per cent. red streaked grains, 12 per cent. big broken grains, 3 per cent. chalky grains, 1 per cent. pitted grains or with slight black streaks, ½ per cent. amber grains, 14 per cent. moisture.

11. "Superior Natural."

A healthy rice, sound quality and fit for the market, obtained from the original Chinese or another similar variety, good average of the year, slightly less light in colour, perfectly dry, second grade cleaning, free from yellow grains.

Allowances :—3 per cent. red streaked grains, 2 per cent. big broken grains, 2½ per cent. chalky grains, 1 per cent. pitted grains or with slight black streaks, ½ per cent. amber grains, 14 per cent. moisture.

The *allowances* are for percentages by weight.

First grade cleaning.—Describes a thorough cleaning of the rough rice for the production of the most valued standards of long, large, or round grain.

Second grade cleaning.—Describes a less thorough cleaning than the above, yet such as to give grain ready for polishing.

Refined cleaning.—Describes cleaning which frees the dehulled rice from all the pericarp, down to the albumen.

"Refined" cleaning can be carried to various degrees of thoroughness, such as the superficial degree, which only removes the pericarp or the full degree which removes the first strata of the albumen.

The present classification of rice for export recognises two degrees of cleaning, the 1st grade corresponds to the full degree, the 2nd grade to the superficial degree.

"*Camolino*" *cleaning.*—Describes a further process of refined cleaning which consists in slightly oiling the surface of the albumen with linseed oil, castor oil, or vaseline.

The several degrees of cleaning answer to corresponding degrees of *Camolino.* For the purposes of this classification "*Camolino*" 1 is obtained from grade "1" cleaning, and *Camolino* "2" from grade "2" cleaning.

Polishing describes a further industrial process in "refined" cleaning which consists in adding a slight trace of glucose and talcum, so as to impart a sheen to the rice.

Here again the degree of polish corresponds to the degree of cleaning. For the purposes of this classification Polished Rice "1" and "2" are obtained from 1st grade cleaning and Polished "3" from 2nd grade cleaning.

Red streaked grain.—Rice longitudinally streaked with more or less deep red colour.

Big broken includes *corpetto* and *mezzagrana* ; it excludes *risina* and *puntina.*

Chalky grain.—Describes grain of opaque, farinacious appearance, due to the rice not being thoroughly ripe.

Pitted grain.—Has small black spots on the surface which do not injure the food value of the rice ; rice with slight black streaks or blotches is classed with pitted grain and included in the same allowance.

Amber grain.—Describes grain less transparent and yellowish in colour.

Types and Official Denominations of National Rice prepared for export.

Standards	Grade of cleaning	Allowances: Red streak-ed	Big broken	Chalky grains	Pitted or black streaks	Amber grain	Moisture
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1. Carolina Sublime Special	1st	10	3	2	¼	..	13½
2. Carolina Sublime	1st	6	3	2	¼	..	13½
3. Carolina Diamond	1st	6	3	3	¼	..	13½
4. Carolina Vittoria	1st	3	2	2	¼	..	13½
1. Giant Extra Polished	1st	2	3	3	¼	..	14
2. Giant Extra Oiled	2nd	2	3	3	¼	..	14½
3. Giant Extra Refined	1st	2	3	3	¼	..	14
1. Superior Splendour or A.A.A.	1st	2	2	2	¼	..	13½
2. Splendour Extra Extra	1st	2	7	2½	¼	..	13½
3. Splendour Extra or A.A.	1st	2	12	2½	¼	..	13½
4. Superior Oiled	1st	2	2	2	¼	..	13½
5. Extra Oiled	1st	2	12	2½	¼	..	13½
6. Superior Natural	1st	2	2	2	¼	..	13½
7. Superior Splendour	2nd	3	2	2½	1	¼	14
8. Fine Splendour	2nd	3	12	3	1	¼	14
9. Superior Oiled	2nd	3	2	2½	1	¼	14
10. Fine Oiled	2nd	3	12	3	1	¼	14
11. Superior Natural	2nd	3	2	2½	1	¼	14

NOTES

THE EFFECTS OF DESICCATING WINDS ON CITRUS TREES.

THE following is the general summary appended to Bulletin No. 484 of the University of California, College of Agriculture and Agricultural Experiment Station, by Messrs. H. S. Reed and E. T. Bartholomew :—

1. Extensive damage to citrus trees exposed to desiccating winds is due to defoliation, death of twigs, and loss of fruit. In addition to the losses incurred by dropping many fruits, the growth of those remaining is so restricted that they are undersized at maturity.

2. Citrus trees suffer from excessive transpiration during the windstorms, as well as from the mechanical force of the wind. The defoliation of orange and some other citrus trees is due principally to windburn and scorch, but the defoliation of lemon trees principally to the mechanical force of the wind. Orange trees are often unsymmetrical in form as a result of the death of young shoots year after year on the windward side of the tree.

3. Trees with a healthy root-system growing in a soil whose water-content approaches the optimum are best able to meet the demands for water incident to the excessive transpiration rate. Trees whose vitality has been lowered by any cause, such as infestation with insects or fungus diseases, are usually more severely injured by the desiccating winds.

4. The desiccating winds, designated northers, blow from the inland deserts to the coastal plain under certain conditions of barometric pressure. Windburn and scorch of citrus leaves are produced when low humidity, high temperature, and high wind velocity are concurrent. In the Imperial Valley the injurious winds blow from the west during the spring months.

5. The water-content of orange leaves when young is greater than at maturity ; however, the young leaves transpire at a slower rate than mature leaves. A large proportion of the transpirational water escapes through the upper, cutinized epidermis which contains no stomata.

6. The total content of soluble solids of mature leaves is much greater than that of young leaves ; likewise the viscosity of the sap of the former is much greater than that of the latter. The content of total solids may materially increase during a period of desiccating wind and then shortly afterward diminish.

7. The sugar-content of young leaves is considerably greater than that of mature ones.

8. Evidence is presented which indicates that the death of the twigs and smaller limbs is caused largely by effects produced by the scorched leaves which remain

attached to them, rather than by the direct effect of the wind. The phloem of these stems turns brown or black, the water-conducting vessels become partially or wholly clogged with gum, and the stem finally dies, while those from which the leaves are detached during the wind storm, or shortly after, usually remain alive.

9. The results of studies on the relation of windbreaks, oil spray, irrigation, cultivation, fertilizer applications, and other factors to the effects of injurious winds are discussed. The minimum damage from the winds has been found in groves where rational practices of tillage and fertilizer application have been followed in conjunction with the development of suitable windbreaks.

ANNUAL REPORT OF THE EMPIRE COTTON GROWING CORPORATION.

THE following abstract from the Annual Report of the Empire Cotton Growing Corporation for 1928-29 will be of interest to many agricultural workers in India :—

INDIA.

The inauguration by H. E. the Viceroy in July, 1929, of the Imperial Council of Agricultural Research was an event of no little significance in the history of India's agricultural progress. It will be recalled that the formation of this body was one of the principal recommendations of the Royal Commission on Agriculture in India. The Imperial Council has been entrusted by the Government of India with the formulation and execution of schemes of research appertaining to all branches of agriculture in India, in pursuance of the suggestion made by the Royal Commission. The Vice-Chairman of the Imperial Council of Agricultural Research is *ex-officio* President of the Indian Central Cotton Committee, and the Expert Adviser in agricultural matters to the Council is also *ex-officio* a member of the Cotton Committee, thus ensuring close contact between the two bodies.

Mention was made last year of the decision to reduce with effect from the 1st July, 1929, the basis of the Empire Futures Contract in the Liverpool Cotton Exchange from " strict low middling " to " low middling ". This provision is now in force and has proved beneficial to the trade in Indian cottons. Further measures with the same object in view have since been formulated by the Federation of Master Cotton Spinners Association, which has asked the Indian Central Cotton Committee for its co-operation with a view to improving the quality of Indian cotton and increasing the use of it in England in the following directions ; (*a*) by setting up definite and reliable universal standards of grades or types of Indian cotton ; (*b*) by setting up in co-operation with Bombay, Karachi, etc., an official type of deferred delivery contract ; and (*c*) by taking such action as may be possible to combat the practice of mixing " desi " cotton with good types, particularly with Punjab-American. Through the courtesy of the Board of the East Indian Cotton Association replicas of official standards were prepared and sent to Manchester. It was

also arranged to send boxes of Sind cotton when the East Indian Cotton Association prepare their official standards at the beginning of the cotton season. It was felt by the Indian Central Cotton Committee that there should be no difficulty in selling on an extended contract in Lancashire, and that any large exporting firm in Bombay or Karachi would be prepared to undertake such business. With regard to (c) the Federation was informed that the Committee in co-operation with trade associations, local Governments, and other bodies was giving its fullest consideration to the question of mixing and to the means whereby this malpractice might be checked.

The improvements that have taken place in Indian cotton, particularly in the direction of longer staple and better grading and marketing, have naturally resulted in Indian cotton becoming more widely known in the European markets. The increase in the continental consumption of Indian cotton may be gathered from the following table :—

Running Bales ooo's.

1926-27		1927-28		1928-29		1929-30
1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half
475	380	442	520	565	585	685

The increase in the United Kingdom consumption of Indian cotton is not less striking :—

Running Bales ooo's.

1926-27		1927-28		1928-29		1929-30
1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half
48	34	47	74	92	91	100

The progress indicated by these statistics is highly satisfactory and points to the conclusion that the demand for Indian cotton in the world's markets is increasing. In this connection it may be noted that Russia imported 52,000 bales of Indian cotton during 1929, and that this is her first appreciable purchase of cotton from India since the war.

The completion of the Sukkur Barrage in Sind will result in a considerable increase in the area under cotton cultivation in India. The problems that await

solution in Sind are many and varied. So far back as 1927 the Indian Central Cotton Committee initiated a research scheme for Sind. The object of this scheme is to investigate certain problems connected with the water requirements, sowing dates and general physiology of the cotton plant under perennial irrigation. The work is being carried out in anticipation of the change-over in Sind from inundation to perennial canal irrigation under the Lloyd Barrage project. The chief obstacle in the past to the growing of long-staple cotton in Sind was the precarious and short water-supply. The supply of perennial water will alter the whole practice of the province, and will give a chance to Egyptian and American varieties. Experiments have shown that the long-staple exotics fall behind the more hardy short-staple cottons in yield, and the Agricultural Department is at present concentrating on the breeding of a hardy and prolific variety of long-staple cotton by selection and acclimatisation and by hybridisation with the 4F Punjab variety. The physiological part of the work is being financed by the Indian Central Cotton Committee.

The fifth official forecast of the Indian Cotton Crop for 1929-30 gives an estimated area of 25,692,000 acres as against 27,053,000 acres, the revised estimate at this date last year, or a decrease of 5 per cent. The total estimated yield now stands at 5,260,000 bales of 400 lb. each, as compared with 5,811,000 bales (revised) at the corresponding date last year, or a decrease of 9 per cent.

Australia.

When the last Annual Report was written, the Cotton Specialist to the Queensland Government foreshadowed a considerable falling-off in the crop for 1928-29, owing to the bad season. Fortunately, in every district where cotton is grown to any extent, there were certain areas which received early local showers, and in those parts, if the farming had been good, early strikes were obtained, resulting in satisfactory yields in such cases. These instances were, however, comparatively few, and the total crop for the season 1928-29 was about 6,000 bales as compared with over 10,000 bales in the previous year.

Writing in March last the Cotton Specialist reported that the prospects for the season 1929-30 were then rather uncertain.

Sufficient seed was issued to plant around 33,000 to 35,000 acres, and it is probable that 30,000 to 31,000 acres are now in varying degrees of development.

South Africa.

Last season's work in South Africa has been a continuation of the development of a supply of cotton seed suitable to the Low Veld. It will be remembered that this was the task entrusted to the Corporation by the Union Government in 1924. It at once appeared that the principal objective must be the production or importation of a variety resistant to the jassid pest, and it is along the former of these lines that the work has continued. The most successful strain, known as Barberton

U.4, was bred from a single plant in 1924-25. During the season 1928-29, an area of about 1,500 acres was planted in the Union with the seed from this plant, and in spite of a late season, drought, and in some cases bollworm, U.4 fully confirmed the favourable impressions that had been formed of it in past seasons. Although selected primarily on account of its jassid-resisting properties, it possesses other valuable qualities which render it particularly suitable to climatic and other conditions, not only in the Union, but in other parts of Africa as well. It shows remarkable resistance to drought, prolific flowering capacity, quickness in forming buds and setting fruit, and is markedly less susceptible than many other varieties to shedding of either buds or bolls. Moreover, in the bulk, which is still far from being uniform, there is a large number of individual plants with excellent lint characters and a high ginning percentage. Last season, in places where the conditions were really good, yields of 1,000 to 1,500 lb. of seed-cotton per acre were not unknown, while under average conditions a crop of 750 lb. per acre should normally be obtained. It may be remarked that hitherto a "bale" of seed-cotton (450 lb.) had been accepted as the standard of a good crop in the Union, so the new variety shows a marked advance in this respect.

Further re-selection work on U.4 has been carried on, and a number of newer selections gave excellent results, yielding from 1,400 to 1,700 lb. of seed-cotton per acre, with lint of good length and quality.

The principal insect problem that still awaits solution appears to be the control of bollworms, more particularly American bollworm and the Sudanese bollworm. Trap crops of ratoon cotton have proved partially successful, and it is a hopeful sign that U.4 has shown itself capable of making a remarkably quick recovery from bollworm attack. Light traps for the moths are also still under trial.

Southern Rhodesia.

In last year's report a summary was given of the work that had been carried out in Southern Rhodesia since the establishment of the Plant-Breeding Station at Gatooma. It will be remembered that the local varieties of cotton had practically entirely succumbed to attack by jassid, and hardly any cotton has been grown in the country in consequence since 1926. A stage has now been reached at which it is believed that cotton-growing is about to be once more launched on a commercial scale, but based this time on surer foundations that have been rendered possible by the breeding by the Corporation's staff of a jassid-resistant variety.

In the season 1928-29, the 1-ton of U.4 seed, which was available at the beginning of the season, was converted into 65 tons through the whole-hearted co-operation of farmers who agreed to sow at a low seed rate, and to pay special attention to the cultivation of the crop in order to achieve the maximum possible multiplication of seed. This multiplication rate is in itself satisfactory, and is all the more so in view of the extremely trying climatic conditions of the season 1928-29.

It would be unwise at the present time to attempt to estimate the potential output of cotton from Southern Rhodesia. It is hoped that the industry will expand, but not more quickly than the supply of improved seed, for it is highly desirable that there should be no general growing of unsuitable seed, which can only eventually cause widespread disappointment. At present a great many farmers regard cotton solely as a rotation crop for maize: if it should subsequently be found to return as good, or even better, profits than that crop, the ratio of one crop to the other will be undoubtedly increased.

Now that the raising of a jassid-resistant variety appears to have been in a large measure achieved, the question as to how far cotton is likely to prove a profitable crop may largely depend on the severity and frequency of bollworm attacks, and the ability of the new selections to give paying crops in spite of them. It is thus to the Breeding Station at Gatooma that the farmers must again look for the production of a suitable early maturing and prolific variety.

Anglo-Egyptian Sudan.

The total output of cotton from the Sudan in the season 1928-29 reached the figure of 161,536 bales of 400 lb., which is a record for the country. The Gezira produced over 110,000 bales, with an average of 3·54 kantars per feddan as compared with 3·3 kantars per feddan in the previous year, and the fact that this slightly higher yield was obtained from an increased area under cultivation renders it the more gratifying.

As regards areas under flood irrigation, the crop at Tokar exceeded 11,000 bales, but was slightly less than the quantity estimated. On the other hand, at Kassala 16,864 bales were produced, which was more than had been anticipated.

Last season for the first time the crop in the Sudan suffered somewhat severely from the disease known as Leafcurl. The scientific staff are working energetically with the object of elucidating the cause of this disease, and the means whereby it is carried. While it is perhaps too soon to say that the responsibility can be attached to one insect alone, the latest reports indicate that sufficient evidence has been accumulated to show that White-fly is certainly largely responsible for transmitting the disease in the Sudan, as it has already been shown to be in those parts of Nigeria in which the same disease occurs.

The other principal disease from which cotton suffers in the Sudan is Blackarm, and further work that has been done in the past year has pointed to the desirability of planting cotton as late in the season as possible, as it has been established that the higher temperatures which then normally occur are unfavourable to the development of the disease. Both these problems were fully discussed at a meeting held in the autumn of the London Supervisory Committee for the Co-ordination of Agricultural Research in the Sudan, with the help of the three technical assessors

appointed by the Sudan Government. The several reports of research work and the programmes for the current session were also reviewed by that body, and are being published by the Sudan Government.

The amount of cotton grown under rainfall showed a very gratifying increase from 4,630 bales in 1927-28 to 8,558 bales in 1928-29. In the present season, the areas in nearly all the provinces again show very substantial increases, and the Government estimate of rainfall cotton at the present time is over 14,000 bales.

The total estimated yield of Sakel cotton for the present season is 529,104 kantars, or 125,662 bales of 400 lb.

	Kantars (315 rotls)
1. Gezira Scheme :—	
Sudan Plantations Syndicate	317,170
Kassala Cotton Company	59,584
2. Gash Delta (Kassala)	100,000
3. Tokar	41,300
4. Private pumping estates	9,000
5. Government pumps	2,050
TOTAL	529,104

Equivalent to 69,812 Egyptian bales (720 lb. lint).

American Type.—The total area of this type of cotton grown under irrigation this season is 17,650 feddans, and the estimated yield 51,820 kantars (11,530 bales of 400 lb.).

As regards American-Type cotton grown under rainfall from the Southern Provinces, which comprise Kordofan, Upper Nile and Mongalla, the estimated output is 57,975 kantars (12,900 bales of 400 lb.). Progress continues to be very satisfactory in the Nuba Mountains area of Kordofan Province. In the Upper Nile output is more or less stationary : conditions for growth appear favourable, but the area is difficult of access, and the people seem hardly ready as yet to respond.

In Mongalla progress has been slower than originally anticipated. In certain areas conditions are fairly reasonable, but elsewhere although growth is fair, a large amount of shedding takes place, with the result that the final output is disappointingly low. So far in such areas it is difficult to say what the reason is —whether soil, climate, or disease (*e.g.*, Blackarm). A theory recently put forward suggests that the heavy shedding may be due to shade effect. Several varieties and different dates of sowing have been tried under the guidance of the Corporation's Plant Breeder, and this year's results point to earlier sowing as beneficial. In the meantime we are marking time in the Yei locality until further investigations have been made.

For comparison, the following represents the output in kantars since this Southern rain-grown cotton scheme was initiated :—

—	1925	1926	1927	1928	1929	1930	(Estimated)
Kordofan (Nuba Mountains Area).	146	3,114	8,436	13,320	24,565	41,270	Kantars.
Upper Nile	1,383	4,690	5,147	2,251	4,666	7,047	"
Mongalla	268	5,075	5,519	3,907	5,892	9,658	"
TOTAL .	1,797	12,879	19,102	19,478	35,123	57,975	"

(*N.B.*—Kordofan includes old Nuba Mountains area. Upper Nile includes old Bahr el Ghazal area.)

The total estimated output of American-type cotton for this season is therefore as follows :—

	Kantars
Irrigated American	51,820
Rain-grown American	64,090
TOTAL .	115,910

Equivalent to 25,790 bales of 400 lb. lint.

Summarised, the total estimated output of cotton from the Sudan for the present season is :—

Sakellarides 529,104 kantars=69,812 Egyptian Bales, 720 lb. lint.
American 115,910 kantars=25,790 bales, 400 lb. lint.

Returned in bales of 400 lb. for comparison with the crops from other countries in the table attached to this Report, the total estimated output is 151,452 bales.

The work of the Plant Breeding Section under Mr. Bailey has been influenced considerably by the prevalence of Leafcurl disease. Unfortunately, many of the most promising hybrids that were being raised from Sea Island and Sakel stock have proved to be specially susceptible and have been abandoned. A large number of selections from amongst Sakel plants has been made, with the sole object of obtaining resistant strains. It seems, however, as if the property of resistance to the disease is better developed among the American-type cottons than among those of the Egyptian type. It may be mentioned that the variety U.4 supplied by the Corporation's Cotton Breeding Station in South Africa has shown resistance to the disease. Variety test plots have again been laid down in most of the rainfall cotton areas in the South, and these were visited by Mr. Bailey in December and January in the course of his visit to Uganda, to which reference is made later.

It is worth recording here that a promising variety of Sakel known as Sakel No. 186 has been bred up by the Corporation's Plant Breeder, as well as a variety of American of the Webber strain which has been given the name "Delreot," and which it is hoped will be found to be suited both for irrigated and rainfall land. Both varieties are now being tried out under field conditions.

Uganda.

Mention was made in this Report last year of the increase in the acreage under cotton in 1928-29 as compared with the previous season. The weather during the ripening period was generally favourable in all parts, and the resulting crop of over 204,000 bales constitutes a record for the Protectorate. The yield from Uganda Province of approximately 170 lb. of lint per acre is particularly satisfactory, comparing as it does with a yield of barley 100 lb. per acre from the Eastern Province. The latter figure was adversely affected by exceptionally heavy rains in Lango district, and by Blackarm disease and the prevalence of stainers in parts of Teso.

The Corporation regard the effective control of the seed supply as no less important, and they welcome the announcement that a scheme has been worked out by the Government for such control in the Eastern Province. A segregated area has there been set apart consisting of 500-600 acres, where pure seed grown at Serere under the Cotton Botanist is to be multiplied for distribution in the following year. Further details of this scheme have been included by the courtesy of the Uganda Government in the Corporation's volume of Reports received from Experiment Stations, 1928-29, published in February last.

At the Cotton Experiment Station at Serere work was carried out under some difficulty in 1928-29, owing to the very dry period from November onwards, which caused the plants to go off rapidly. Nevertheless, progress was made notably in the multiplication of a selected strain which will be planted in the Government's segregated area in the Eastern Province referred to above.

Blackarm is reported to have done a considerable amount of damage at the Station, whilst stainers were also much in evidence. The apparent increase in the area affected by Blackarm disease constitutes a disquieting feature in the record of the Uganda crop. Research work on Blackarm is being vigorously prosecuted, especially in the Sudan, and it is hoped that it may suggest some means of controlling the disease or of mitigating the damage caused thereby which may be applicable to Uganda and other countries.

Tanganyika Territory.

In the season 1928-29 the rainfall was low in most provinces of the Territory, and in those areas in which the total amount for the season was adequate, the onset of the rains was belated. A general shortage of food crops was feared, but prospects improved in most parts as the season advanced, and the position in this respect

was satisfactory at the end of the season in most districts. The cotton crop fell just short of 30,000 bales, about 3,500 bales less than in the previous season.

For the markets in the Morogoro-Kilosa area supervisors have been provided through a cess collected on all purchases of native seed-cotton. The Agricultural Department state that the scheme has proved successful, and it is proposed to extend it to other areas.

Samples from most of the principal cotton-growing districts are forwarded to the Corporation each season by the Director of Agriculture for brokers' reports and spinning tests. Those of the 1928 crop were received and tested last year with satisfactory results. The staple length of most of the samples was reported as $1\frac{1}{8}$ in. to $1\frac{3}{16}$ in., while in the spinning tests the best samples were described as being capable of spinning 62's, while the worst were reported to give a good twist yarn at 50's.

NYASALAND.

Cotton-growing developments in Nyasaland are highly gratifying. The crop in 1928-29 exceeded 6,000 bales, as compared with 4,470 in the previous year, and probably nearly 90 per cent. of it was grown by natives in the Lower Shire area. Moreover, there are good reasons for hoping that the output will increase very considerably before long because (i) the good yields obtained from the strain produced at the Corporation's Station at Makwapala are inclining European planters to take up cotton again as a rotation to tobacco, (ii) the success of the strains produced and of the experiments on the best time of planting carried out at the Port Herald Station should lead to a very substantial increase in the average yield per acre in that area, and (iii) transport developments in the Protectorate will enable promising potential cotton-growing areas to be brought into cultivation, in which the growing of an export crop is at present economically impossible owing to lack of communications.

The two tables given below, showing the output of cotton grown by natives in Nyasaland for the past 10 years, and the production by natives for the last 5 years, divided into districts, may be of interest.

Native Production of Seed-Cotton (*Tons*).

1920	315
1921	375
1922	392
1923	747
1924	1,369
1925	2,909
1926	2,197
1927	1,387
1928	2,486
1929	3,505

District	1925	1926	1927	1928	1929
1. Lower Shire . . .	1,692	1,266	779	1,586	1,809
2. Chikwawa . . .	454	571	352	680	1,248
3. Central Shire . . .	153	165	147	120	195
4. Malanje	85	89	25	10	14
5. Blantyre . . .	..	25	24	18	10
6. Ncheu	99	34	16	14	47
7. Upper Shire . . .	62	3	11	9	18
8. South Nyasa . . .	142	12	4	1	18
9. Dedza	51	20	21	11	51
10. Dowa	12	12	8	37	95
11. Kotakota . . .	1	..	..	..	..
12. Karonga . . .	158	..	..	..	..
TOTAL .	2,909	2,197	1,387	2,486	3,505

NIGERIA.

Satisfactory reports continue to be received from the Corporation's seed farm at Daudawa. It will be remembered that certain parts of the area originally allotted by the Government were found to be unsuitable for agricultural purposes: additional land has accordingly been placed at the Corporation's disposal, and extensions which will amount ultimately to a further 770 acres are now being undertaken. During last year 210 acres were cleared, thus completing the original block of 480 acres, which is now all under cultivation. In addition, a further 134 acres have been cleared since last July.

The 170 acres under cotton in the season 1928-29 gave a yield of 264 lb. of seed-cotton per acre. This result is less than was originally hoped for, and the reduction was due mainly to a somewhat severe attack of bollworm and to a less degree to the fact that two fields suffered also from Leafcurl disease. The total quantity of seed produced was 36,650 lb., of which 34,960 lb. were handed over to the Department of Agriculture for distribution, and the balance, which was not considered up to the standard required for this purpose, was used for cattle feed. The lint had an average staple of 1⅛ in., but was rather lacking in uniformity; it was sold at 110 points on Middling American.

The seed supplied from the Government farm at Maigana was a selection from Allens, and very favourable reports were given of it at the picking season, when the lint was described as being of good quality and staple, and freer from nep than that from last year's crop.

RESEARCH.

RESEARCH STATION, TRINIDAD.—It was stated in this Report last year that the physiological work of the Station had already been of assistance to the botanists in the Sudan in the work which they were carrying out on Blackarm. It will doubtless interest members to know that the Director of the Shirley Institute considers that this same work may also throw light on the causes of " neppiness " in cotton, and has expressed the opinion that improvement in the quality of cotton, irrespective of staple length, and information of value to the finishing trade, are practical results to which this work may quite possibly lead.

Physiology Department.—During the year, a number of papers on the transport of nitrogen have appeared in the *Annals of Botany.* The first three of these have been collected and issued by the Corporation in a publication constituting the second Memoir of the Physiology Department of the Station. Further contributions on this subject will appear in the *Annals* during 1930. They will subsequently be issued together as a third Memoir. These papers will be followed by others dealing with the movement and storage of other elements in the cotton plant.

" This line of work promises to develop in an interesting way. As a result of it, we foresee the possibility of using the chemical composition of the plant as an indicator of the nutritional status of the soil. Stated very briefly, we find that an element, such as potassium, has at times a greater concentration at the apex than at the base of the stem, while at other times the reverse obtains. This change in the direction of the potassium gradient appears to depend on the potassium supply at the disposal of the plant. Whether further work will substantiate this tentative suggestion, we cannot of course say, but we are planning experiments to test it out.

" Our first paper on boll-shedding should also appear shortly. We have found that the first symptom preparatory to shedding is a limitation in the uptake of carbohydrate by boll and pedicel. This occurs some 4 or 5 days before shedding. A day or so before the completion of abscission, a change occurs in the acidity of the sap. Why a limitation in the uptake of carbohydrates should be followed by a change in sap acidity is not yet clear. Contrary to the generally accepted view, there does not appear to be any grounds for the view that a water shortage in boll and pedicel is the primary stimulus for abscission.

Recently the idea has been advanced that the electrical conductivity of the leaf sap might prove a useful indicator of the suitability of strains of cotton to saline conditions. So far as our observations go, it appears that the electrical conductivity of the sap depends on a number of very obscure factors, and it seems doubtful,

until a great deal more is known about the subject, whether it can be of much practical utility. A paper on this subject will also appear in the near future."

It will be seen that the general line that is being followed in the work is to trace the means by which the plant food is transported through the plant and delivered to the boll, where it forms cellulose.

Genetics Department.--Dr. Harland's report on the year's work is as follows :—

" Studies of inheritance in both New and Old World cottons have been continued. The crosses which have previously been referred to between *Gossypium tementosum* (the wild species from Hawaii) and Upland are being studied in detail. Our principal economic aim in this case is to elucidate the mode of inheritance of the hairiness of *tomentosum*, with the object of transferring it to Upland varieties. The effect of this may be greatly to modify the reaction of Upland cotton to drought conditions.

Three further papers constituting the second Memoir of the Genetics Department are shortly to be published. One of these papers deals with correlation of hair characters in various parts of the plant, and it is shown that replacement of the factor for fuzzy seeds by its naked allelomorph results in a loss in the amount of lint per seed of about 25 per cent. The other two papers deal respectively with the inheritance of seed fuzz and with anthocyanin pigmentation.

The new type of big-bolled Upland cotton with a weight of lint of over 10 grammes per 100 seeds is maintaining its purity, and will shortly be ready for extended trial.

A large number of crosses are being studied. This work is mostly routine, and has to be got out of the way preparatory to more intensive studies of economic characters. We have concentrated on inter-Upland crosses this year, as the results of inter-specific crosses are complicated by the phenomenon of " blending inheritance ", which we have shown to be due to segregation of modifying factors. If crosses are made between nearly related types, segregation is more apt to be clear and straightforward.

Papers on the inheritance of chlorophyll deficiency, leaf shape and crinkled dwarf rogue are being written up."

MANCHESTER UNIVERSITY.—At the University of Manchester, experiments were carried out to ascertain the effect of various kinds of soil and various dates of sowing on the susceptibility of the cotton plant to the attacks of thrips. Experiments were also made in the same direction with variations in temperature and humidity to which the plants were subjected. This work is being continued.

In the Mycological Department several fungal parasites of the cotton plant were cultivated in the laboratory to determine the conditions under which the several kinds of sports which they produce are formed. The susceptibility of the parasitic organism to changes of temperature was also investigated.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY.—The recent work of the Biology Department of the College, which is of most interest to the Corporation, deals with the sterilisation of seeds and the testing of the viability of seeds. Con-

siderable work has been done on the most satisfactory method of ridding seeds of insect infestation. Hydrocyanic acid gas is most widely employed at present, but some risk is attached to its use on account of its high toxicity. Other cheap and toxic fumigants are available, but they are highly inflammable. The best non-inflammable and non-explosive fumigants are carbon tetrachloride and trichlorethylene. By themselves, however, these substances are not very efficient, so experiments are being conducted in which these are mixed with others such as carbon disulphide, ethyl acetate, etc. Such tests now in progress should render a wider range of fumigants available and make fumigation a safer operation and, it is hoped, a cheaper one.

A number of consignments of cotton seed from various countries have been sterilised at the request of the Corporation, the method used being a combined treatment with heat and with hydrocyanic acid.

Tests are being conducted of a possible method of determining the viability of cotton seed by the use of a solution of a dye. It is well known that many dye solutions are rapidly taken up by dead plant tissues but fail to stain living tissues. It has been claimed that by means of a dye like indigo carmine, a test of the number of viable seeds in a sample can be made in a few hours, instead of the days required for a germination test. If the outer coating of the seed be broken so that the embryos are exposed to the dye solution, the living ones remain uncoloured while the dead ones are deeply stained. This method is being studied, a careful comparison being made between the results of such a test and an ordinary germination test. Such a test, however, though it may give information rapidly as to the number of living seeds in a sample, can hardly give information as to germination vigour.

ROTHAMSTED EXPERIMENTAL STATION.—Several Departments are engaged on work directly bearing on problems of cotton cultivation. Dr. Keen and the staff of the Physics Department have been studying rotary methods of cultivation, which if successful would greatly simplify the work of cotton-growing by producing a seed-bed in one operation and maintaining the land easily and relatively inexpensively in clean condition. Although in any particular region the final test must always be on the land itself, these investigations will save the overseas worker much preliminary labour by showing the lines on which the tests are best carried out and the kind of effects that should be looked for. Rotary cultivation does not produce a very fine tilth, but it leaves the seed-bed in a loose condition that encourages early germination of the seed and rapid growth of the young plant. Later on, however, the effect ceases and the subsequent stages of growth are no better, and may even be worse, than on land cultivated in the usual way.

Investigations are proceeding on the deterioration of soil resulting from saline or alkaline conditions to which many cotton areas are liable.

Dr. Fisher and the staff of the Statistical Department have helped a number of experimenters dealing with the cotton crop in designing their field trials and

interpreting the results: they have also demonstrated to certain officers on leave suitable methods for applying tests of the statistical significance of results.

In the Chemical Department, Dr. E. M. Crowther and his staff have studied certain analytical difficulties encountered with samples of tropical soils. The standard methods not infrequently break down with these soils, and search is being made for the causes, with special reference to the determination of acidity, alkalinity and mechanical analysis, which are of importance in formulating advice on problems of manuring and cultivation. The increased use of some of the newer fertilisers, such as cyanamide, has necessitated renewed attention to the problems of nitrification in the field to which reference was made in last year's Report. In addition, work is in progress on the decomposition and utilisation of green manures and crop residues.

In the Department of Mycology, Mr. R. H. Stoughton is studying the Blackarm or Angular Leaf Spot disease of cotton. The work falls under two main heads, (i) the influence of environmental conditions on the disease, (ii) the life-history of the bacterium responsible. The studies on climatic factors are being carried out in specially designed chambers in which plants can be grown under controlled conditions. Air temperature has a considerable influence on the amount of disease developing on seedlings, but soil temperature plays a less important part than had been supposed by other workers. This investigation is being made in close co-operation with workers in the cotton-growing countries of the Empire. Studies on the behaviour of the organisms in culture have revealed new phases in its life-history, which may prove to be of considerable importance in the persistence and spread of the disease. In particular, it has been found that the bacterium can change, apparently suddenly, in several of its characters, and that one or more of the new forms so produced may be innocuous, while later these non-virulent types may revert to the destructive form. The Empire Marketing Board provided the funds for the erection and maintenance of the rather costly equipment needed for this investigation.

NOMENCLATURE OF SUGARCANE VARIETIES.

We have received the following for publication from the General Chairman, International Society of Sugarcane Technologists :—

Many people in the various sugar-growing countries of the world travel to other cane-growing countries and make very thorough and extensive investigations and reports on these other countries to their home industry. The Committee on "Description and Identification of the Original Cane Varieties" appointed at the Third Congress of the International Society of Sugarcane Technologists would greatly appreciate having a memorandum or report on the similarity or dissimilarity of nomenclature of cane varieties. In this way the problem of straightening

out mixed nomenclature will be greatly aided. Many of these notes are to be found scattered throughout old sugar publications, but a great deal of time is necessary to collect them and verify them. It is hoped that all people who have visited any other country and noted their cane varieties, will kindly send us a brief report on their observations on cane nomenclature in this other country as compared to their own. Please forward such reports to the Committee Chairman, W. W. G. Moir, Box 3230, Honolulu, Hawaiian Islands.

AN OPEN LETTER TO ALL SUGAR TECHNOLOGISTS.

We have received the following for publication from the General Chairman, International Society of Sugarcane Technologists :—

At the Third Congress of the International Society of Sugarcane Technologists, held at Sourabaya, Java, in June, 1929, the following resolution was unanimously adopted :—

" Whereas the current technical literature on sugarcane and beet is published in a large number of periodicals and often is written in a language which is only understood by a minority of the technologists or is not available in the local libraries ;

Whereas further re-enforcement of the interest of organizations and of the personal members of our Association is desired for further development of the activities of the Association ;

Be it resolved that a new periodical be started containing (or an existing periodical be requested to print) adequate abstracts in the English language, submitted by the authors themselves of all technical papers of more general importance ;

And be it further resolved that a committee be appointed by the chairman to devise ways and means for carrying this resolution into effect."

Publication Plan Adopted.

The committee appointed in accordance with this resolution and consisting of H. P. Agee (Hawaii), chairman ; K. Douwes Dekker (Java), R. Fernandez Garcia (Porto Rico), A. H. Rosenfeld (Louisiana), and W. B. Saladin (Cuba), has given this project very careful consideration, and has discussed a number of plans. The first of the two methods mentioned in the resolution, *viz.*, publication of such a journal under the financial responsibility of the Society itself, has been deemed to be impracticable in the present status of our Society, because the latter has no funds available to apply to such an undertaking, and a campaign for the needed funds, even though possible in itself, would greatly delay the launching of the periodical. The second plan, however, appears feasible immediately, and the chairman of the committee, with the approval and consent of the other members, has authorized the general chairman of the Society to enter into negotiations with Mr. E. W. Mayo, Editor of *Facts About Sugar*. A preliminary conference accordingly has been held between Mr. Mayo and the general chairman of the Society, and the

former has agreed to publish all abstracts which the Society may furnish through any or all available channels. A section with appropriate heading will be set aside, and pursuant to the wishes of the committee, abstracts concerning the agricultural phase of the cane sugar industry will be separated from those relating to the manufacturing side. Owing to the character of the Society, sugar beet growing for the present will not be considered, but it is desired to include beet sugar manufacture, because in the manufacturing field the problems of the two industries are in many instances quite similar.

Supply of Abstracts.

Turning now to the question of the abstracts themselves, it has been the custom with journals of a similar character to employ paid abstractors, each one of them taking care regularly of a certain number of journals of a certain specialized branch of knowledge. The Society is at present financially unable to pursue such a course. But it is believed, and this belief is expressed in the text of the resolution, that every author who is interested in having his work published and made known to the world is quite as much interested not only in securing as large as possible a circle of readers for his own publications, locally as well as universally, but also in having ready and convenient access to all the literature in his field appearing anywhere in the world, in any language. After an author has taken considerable time to collect his data and to put them down in words, it requires only an additional fraction of the time consumed to prepare an abstract giving the salient features of the article. It is often said that trained abstractors are better able to do this than many of the authors themselves. While this may be generally true, the writer has noticed not a few instances where an abstractor has missed a point or misconstrued the statements of an author. Another important point is that abstracts, in contradistinction to critical reviews, should be informative only, and the preparation of the abstracts by the authors themselves safeguards this feature. A certain amount of editing of the abstracts is necessary, to be sure, in order to guarantee a uniform policy ; this part of the work will be handled by the Technical Editor of *Facts About Sugar*, in co-operation with the officers of the Society.

The co-operation of all the sugar journals all over the world, of government departments, experiment stations, local technologists' associations, etc., will be necessary and is earnestly solicited. In some cases it may be possible to make special arrangements with established abstract journals to reprint abstracts of articles appearing in other than sugar journals, which are of interest to sugar technologists, such as for instance on sugar chemistry, plant physiology, phytopathology, the various branches of engineering, and such like.

The Editor of *Facts About Sugar* has also offered to furnish reprints of the abstract pages at cost, in the more handy form of 15 × 23 cm., with two columns instead of three. An exact price per year cannot be fixed until it is known how much space will be required.

Co-operation Necessary to Plan.

The success of the journal will depend entirely on the interest shown and on the amount of co-operation given by each member of the Society and by each author, whether or not he is a member of the Society.

The publication of the abstracts will begin as soon as a sufficient number is received by the Editor of *Facts About Sugar*, 153, Waverly Place, New York City. Orders for subscriptions to the reprints should also be addressed to him. It is intended to include all articles which have appeared since January 1, 1930, so as to have a complete record for the present calendar year. Authors please note!

A supply of copies of this letter will be sent to each vice-chairman of the Society, and they will be requested :—

(1) To distribute these copies among the members of the Society. Additional copies will be sent on request.

(2) To point out to all sugar technologists in their territory the necessity of sending in abstracts of all articles they publish, not later than the time they appear in print. In some cases where publication is liable to be delayed, it will be preferable to forward the abstract when the article is transmitted to the publisher; the abstract will in such cases be held at the office of *Facts About Sugar* and the reference inserted after the article has actually been published. General directions concerning the nature and style of the abstracts are given below: they are patterned after those adopted by *Chemical Abstracts*.

(3) To examine periodically all the technical sugar literature published in their territory and to ascertain whether all of it has been abstracted and abstracts have been forwarded. If any articles have been omitted, the vice-chairman is requested to send the titles of them to the Editor of *Facts About Sugar*, preferably accompanied by the abstract.

The vice-chairmen are further requested to notify the Editor of *Facts About Sugar*, on the return card sent to them, whether they are willing to co-operate in the way indicated above. If for any reason they are unable to undertake these duties they are expected to appoint a committee of one or more members in their territory who express a willingness to act in that capacity.

Any articles noted in the literature by the Technical Editor of *Facts About Sugar*, for which articles no abstracts have been received in a reasonable time, will be reported by title only. It will therefore be to the interest of each author to send in abstracts promptly. The responsibility for the success of the new venture rests upon each individual sugar technologist.

General Directions for Abstracting.

Nature of Abstract.—The abstract should contain all important new information in sufficient detail to give a clear idea of what has been accomplished. The general reader should not find it necessary to refer to the original, and the specialist should be able to judge from the abstract whether or not he will have to do so. Abstracts of articles which originally appear in any of the less known languages, especially those of the Slav and Asiatic groups, should generally be given in greater detail. The abstracts of technical research work should not be in the form of summaries merely stating the subject treated and the results obtained, but should be analytical in nature, along the following general plan. They should include, in the order given, a statement of :—

(1) The purpose of the investigation.
(2) The methods by which the worker has approached his subject, and by which he has obtained a solution of his problem.
(3) The results actually obtained, and the conclusions drawn by the author of the article.

Such analytical abstracts are not necessary in the case of articles which merely represent discussions, restatements, or reviews of the literature, new books or monographs, criticisms of other articles, etc. In these cases descriptive abstracts will usually suffice, each individual instance to be judged separately by the author and editor.

Language.—All the abstracts are to be published in English, but if the author who prepares the abstract is not sufficiently conversant with that language, they may be sent in in Dutch, French, German, or Spanish, and such abstracts will be translated through the editorial office.

Abbreviations.—No abbreviations should be used by the authors. The editor may introduce suitable abbreviations, a key to which is to be printed in the journal.

Manuscript.—Whenever possible abstracts should be typewritten, double-spaced, on one side of the paper only. If the author is unable to furnish typewritten copy, he should write as legibly as possible.

Heading of Abstract.—The headings should invariably be given in the following order :—

(1) Title of article.
(2) Full names of author or authors.
(3) Name of journal.
(4) Serial number of the volume of the journal.
(5) Page number on which the article begins and page number on which it ends, with a dash between the two, thus : 512-625.
(6) Year in which the article has been published, in parentheses, thus : (1930).

An example follows :—

Polarization apparatus with photo-electric indication. W. E. Dickes. Z. Zuckerind. Czech. Rep. 51, 379-80 (1927).

Tables, Graphs, and Drawings.—These should be used only when the information cannot be given in words in less space. In some cases graphs and drawings may actually save space : they should be sent in such form as to be reproducible without redrawing.

References.—References to previous literature should always be given, to assist the research worker. As soon as this journal has become established, reference should be made to abstracts previously appearing in it.

According to the Java mutual factory control data for the 1929 sugar campaign, compiled from reports received from factories, 58 worked with the defecation process, 73 with the sulphitation process and 48 with the carbonatation process. A. Van Leer in *Java Mededeelingen*, 1930, gives data for 178 of the 179 factories in operation in 1929. The following averages are instructive :—

Cane per hectare=125 metric tons.
Sugar per hectare = 14·8 metric tons.
Average rendement = 11·82 per cent.

The Pasoeroean Sugar Experiment Station reports the area under cane in Java for the 1930 crop now being harvested as 198,377 hectares (490,110 acres) compared with 196,675 hectares (485,984 acres) in the preceding year. This represents an increase of 0·9 per cent. The average area per factory is 1,108 hectares for the 1930 crop as against 1,099 hectares for 1929.

Personal Notes, Appointments and Transfers, Meetings and Conferences, etc.

DIWAN BAHADUR SIR T. VIJAYARAGHAVACHARYA, K.B.E., Vice-Chairman, Imperial Council of Agricultural Research, has been placed on deputation in Europe with effect from the afternoon of the 18th September, 1930.

MR. M. S. A. HYDARI, I.C.S., Secretary, Imperial Council of Agricultural Research, has been appointed to hold charge of the current duties of the post of Vice-Chairman of the Council, in addition to his own, during the absence of Diwan Bahadur Sir T. Vijayaraghavacharya on deputation in Europe.

MR. T. S. SABNIS, B.A., M.Sc., I.A.S., Second Economic Botanist to Government, United Provinces, has been appointed temporary Hemp Marketing Officer, Imperial Council of Agricultural Research, with effect from the forenoon of the 1st September, 1930.

MR. G. R. DUTT, B.A., Personal Assistant to the Imperial Entomologist, Imperial Institute of Agricultural Research, Pusa, has been appointed temporary Entomologist, Locust Bureau, Imperial Council of Agricultural Research, with effect from the forenoon of the 22nd April, 1930.

MR. W. SMITH, Imperial Dairy Expert, was on combined leave for three months and 27 days with effect from the 11th July, 1930.

MR. Z. R. KOTHAWALA, B.AG., B.Sc., N.D.D., Assistant to the Imperial Dairy Expert, acted as Imperial Dairy Expert during the absence, on leave, of Mr. W. Smith.

MR. F. E. TRAYNOR, Superintendent, Cattle Breeding Farm, Karnal, acted as Assistant to the Imperial Dairy Expert, *vice* Mr. Kothawala officiating as Imperial Dairy Expert.

Mr. V. Krishnamurthi Ayyar Avargal, G.M.V.C., I.V.S. (Madras), has been provisionally granted leave on average pay for ten months pending orders of the Government of India regarding his eligibility for special leave rules.

Mr. R. O. Iliffe, M.A., Dip. Agri. (Cantab.), Paddy Specialist, Madras, has been granted leave on average pay for four months with effect from 27th July, 1930.

Mr. K. Ramayya Avargal, M.Sc., Dip. Agri. (Cantab.), L.Ag., Superintendent, Agricultural Research Station, Aduturai (Madras), has been appointed Paddy Specialist, Coimbatore, *vice* Mr. R. O. Iliffe granted leave.

A special temporary post on Rs. 320—40—1,200 from 1st October, 1929, has been created by the Bombay Government, and Mr. N. V. Kanitkar has been appointed to hold it while doing duty as Soil Physicist to Government.

Mr. P. B. Richards, A.R.C.S., F.E.S., Entomologist to Government, United Provinces, has been granted leave on average pay for a period of seven months and fourteen days out of India from July 10, 1930, or subsequent date of relief.

Pandit Har Narayan Sharma, B.A., Assistant Entomologist to Government, United Provinces, has been appointed Entomologist to Government, United Provinces, in the United Provinces Agricultural Service as a temporary measure, *vice* Mr. P. B. Richards granted leave.

Mr. P. S. Viswanathan, Third Agricultural Engineer to Government, United Provinces, has been granted leave on average pay for four months from July 10, 1930, or subsequent date of relief.

Mr. Balmukund Kapoor, Assistant Agricultural Engineer, Second Circle, Bareilly, has been appointed to officiate as Third Agricultural Engineer to Government, United Provinces, *vice* Mr. P. S. Viswanathan granted leave.

DR. P. E. LANDER, M.A. (CANTAB.), D.Sc. (LONDON), A.I.C., I.A.S., Agricultural Chemist to Government, Punjab, Lyallpur, has been appointed incharge of the duties of Principal, Punjab Agricultural College, Lyallpur, with effect from the 17th July, 1930, in addition to his own duties and relieving Mr. T. A. Miller Brownlie, Agricultural Engineer to Government, Punjab, of the additional charge.

MR. J. S. GAREWAL, M.R.C.V.S., I.V.S., Live-stock Officer and Assistant to the Director of Veterinary Services (for Breeding), Punjab, was transferred from Lahore to Patna from the 17th April, 1930, to officiate as Director, Civil Veterinary Department, Bihar and Orissa, for seven months.

MR. T. G. QUIRKE, M.R.C.V.S., I.V.S., Director, Veterinary Services, Punjab, performed the duties of Live-stock Officer and Assistant to the Director, Veterinary Services (for Breeding), in addition to his own, *vice* Mr. J. S. Garewal, transferred to Patna, from the 17th April to the 11th August, 1930.

On completion of the Post-graduate Refresher Course at the Imperial Institute of Veterinary Research, Muktesar, Mr. P. N. Nanda, M.R.C.V.S., assumed on the 12th August, 1930, the post of a Temporary Officer appointed to perform the duties of Live-stock Officer and Assistant to the Director of Veterinary Services (for Breeding), Punjab, for the remaining period of Mr. Garewal's deputation to Bihar and Orissa.

MR. SETH MOHAMMAD SARWAR, M.R.C.V.S., Officer under training at the Government Cattle Farm, Hissar, has been appointed Assistant Superintendent (Stock), Government Cattle Farm, Hissar, *vice* Mr. P. N. Nanda, with effect from the 17th April, 1930 (afternoon).

The appointment of MR. BAIJ NATH HANDA, M.R.C.V.S., to a special temporary post in the Civil Veterinary Department, Punjab, for a period of two years, has been extended for a further period of one year, with effect from the forenoon of the 12th March, 1930, pending the formation of the Superior Provincial Veterinary Service.

The appointment of MR. SAYED IQBAL ALI SHAH, M.R.C.V.S., to a special temporary post in the Civil Veterinary Department, Punjab, for a period of two years, has been extended for a further period of one year, with effect from the forenoon of the 22nd March, 1930, pending the formation of the Superior Provincial Veterinary Service.

Mr. R. A. Beale, Assistant Director of Agriculture, Burma, has been appointed substantively to the Burma Agricultural Service (Class I) with effect from the 4th November, 1929.

Captain J. B. Idle, M.R.C.V.S., I.V.S., Deputy Director of Veterinary Services, Burma, has been granted leave on average pay for eight months with effect from the 11th April, 1930.

On return from the leave granted to him, Mr. J. C. McDougall, M.A., B.Sc. (Edin.), has been posted as Deputy Director of Agriculture in charge of Agricultural Economics and Marketing, Central Provinces, Nagpur.

On return from the leave granted to him, Mr. S. G. Mutkekar, B.Ag. (Bomb.), M.Sc. (Mass.), Deputy Director of Agriculture, Central Provinces, has been reposted to the Western Circle.

Rai Sahib Bhaiyalal Dube, L.Ag., Extra-Assistant Director of Agriculture, has been appointed as Deputy Director of Agriculture in the Field Experiment and Extension Branch in the Central Provinces Agricultural Service, Class I, with effect from the 1st June, 1930.

Mr. Dina Nath Mahta, B.A. (Oxon.), F.L.S., has been appointed as an Economic Botanist in the Central Provinces Agricultural Service, Class I, with effect from the 11th July, 1930.

Sardar Sampuran Singh, Honorary Secretary to the Lyallpur Central Co-operative Bank, Ltd., has been appointed a member of the Indian Central Cotton Committee to represent co-operative banking, *vice* Rao Saheb V. Krishna Menon retired on completion of his term of office.

REVIEW

Principles of Tropical Agriculture—By H. A. Tempany, D.Sc., F.I.C., F.C.S., and G. E. Mann, M.A. Pp. xxiii+328; 25 illus. (Published by the Incorporated Society of Planters, Malaya, Kuala Lumpur, F. M. S.)

This publication is primarily intended to fill the need for a generalised text-book in connection with the system of examinations in agriculture and agricultural practice instituted by the Incorporated Society of Planters. The book is divided into two parts, the first dealing with the factors governing growth and their operation as affected by geographical distribution, and the second with the chief methods employed in tropical agriculture in the light of the various factors mentioned in Part I. No attempt is made to describe the agriculture of particular crops in detail, and consequently a more extensive bibliography would have been of immense benefit to users of the book who desire fuller information on various aspects of individual crops.

An enormously wide field is traversed within its 328 pages. As a consequence the information contained therein is comparatively concentrated, and in at least one case is so scanty that it may leave a wrong impression on the mind of the student; *e.g.*, on page 148 "Cultivation of Wet Rice" it is said "moreover the subsoil should also be heavy and cultivation should aim at the creation of a definite pan at no great distance beneath the surface, thus providing an impervious layer which would effectively resist percolation and economise water". Yet previously on page 134 a pan is described as a source of infertility, and in several places the necessity for aeration of the soil and supply of oxygen to the plant roots is stressed. The supply of oxygen to the roots of the wet rice plant is partly explained on page 194 in the chapter on irrigation where the authors state, "Under ideal conditions, provision should be made for changing the water in the fields at frequent intervals in order to ensure sufficient aeration of the soil, but such an ideal makes an enormous demand on the source of irrigation water, and can seldom be realised in practice over any large area like Krian in Malaya". How then under conditions as found in Krian does the wet rice plant conform to the principles enunciated in the book, and how are the roots saved from asphyxiation?

In the chapter on irrigation nothing is specifically said on the "duty" of water. This is a grave omission.

In Chapter XI on cultural implements one or two unsatisfactory statements appear, *e.g.*, in the second paragraph on page 155 the authors in writing of wheeled

ploughs say that "the setting of the furrow-wheel determines the width of the furrow slice while that of the land-wheel regulates the depth of ploughing". This is not so if the plough is not correctly set.

The general lay-out of the book is good and a suitable index is provided. The illustrations might be more profuse. For general knowledge purposes, it should prove a useful addition to agricultural literature. [D. G. M.]

NEW BOOKS

On Agriculture and Allied Subjects

1. A Text Book of Dairy Chemistry, Theoretical and Practical for Students of Agriculture and Dairying, by Edgar R. Ling. Pp. vii+213. (London: Chapman and Hall, Ltd.) Price, 6*s*. net.
2. The Organisation of Farming, Vol. I: Production, by G. T. Garratt. Pp. 164. (Cambridge: W. Heffer and Sons, Ltd.) Price, 6*s*. net.
3. Vegetable Growing, by J. E. Knott. (London: Henry Kimpton.) Price, 15*s*. net.
4. Colloids: A Textbook, by H. R. Kruyt. Translated from the Manuscript by H. S. Van Klooster. Second edition, revised and enlarged. Pp. xiii+286. (New York: John Wiley & Sons, Inc.; London: Chapman and Hall, Ltd.) Price, 17*s*. 6*d*. net.
5. Mendel's Principles of Heredity, by W. Bateson. Fourth impression. Pp. xvi+414+6 plates. (Cambridge University Press.) Price, 15*s*. net.
6. Histological and Illustrative Methods for Entomologists, by H. Eltringham. With a Chapter on Mounting Whole Insects, by H. Britten. Pp. xi+139. (Oxford: Clarendon Press; London: Oxford University Press.) Price, 7*s*. 6*d*. net.
7. The Coconut Moth in Fiji; a History of its Control by means of Parasites, by J. D. Tothill, assisted by T. H. C. Taylor and R. W. Paine. Published for the Government of Fiji. Pp. vii+269. (London: The Imperial Bureau of Entomology.)
8. British Poultry Husbandry: Its Evolution and History, by Sir Edward Brown, LLD., F.L.S. Pp. viii+350. Illustrations. (London: Chapman and Hall, Ltd.) Price, 15*s*. net.

The following publications have been issued by the Imperial Department of Agriculture since our last issue:—

Memoirs.

1. Studies in Soil Colloids, Part I—Base exchange and soil acidity; Part II—Factors influencing the dispersion of soil colloids in water, by Amar Nath Puri, M.Sc., Ph.D., A.I.C. (Chemical Series, Vol. XI, Nos. 1 and 2.) Price, Re. 1 or 1*s*. 9*d*.
2. The Nutritive Values of some typical Indian Hays, by F. J. Warth, M.Sc. (Chemical Series, Vol. XI, No. 4.) Price, As. 5 or 6*d*.

3. The Nutritive Value of Gram Husk, by F. J. Warth, M.Sc. (Chemical Series, Vol. XI, No. 5.) Price, As. 6 or 8*d.*
4. Studies in Soil Colloids, Part III: Flocculation of soil colloids, by Amar Nath Puri, Ph.D., M.Sc., A.I.C. (Chemical Series, Vol. XI, No. 6.) Price, As. 5 or 6*d.*
5. Studies in Soil Colloids, Part IV. Methods of estimating soil colloids, by Amar Nath Puri, Ph.D., M.Sc., A.I.C. (Chemical Series, Vol. XI, No. 7.) Price, As. 5 or 6*d.*
6. Studies in Soil Colloids, Part V: Methods of determining saturation capacity and degree of saturation of soils, by Amar Nath Puri, Ph.D., M.Sc., A.I.C. (Chemical Series, Vol. XI, No. 8.) Price, As. 3 or 4*d.*
7. The Influence of Exchangeable Ions in Soil Colloids on Bacterial Activity and Plant Growth, by N. V. Joshi, B.A., M.Sc., L.Ag., and A. N. Puri, M.Sc., Ph.D., A.I.C. (Bacteriological Series, Vol. II, No. 4.) Price, As. 7 or 9*d.*
8. Classification and Study of the characters of the cultivated Rices in the United Provinces, by R. L. Sethi, M.Sc., B.Sc., M.R.A.S., and Baijanti Prosad Saxena, L.Ag. (Botanical Series, Vol. XVIII, No. 6.) Price, Rs. 1-10 or 2*s.* 6*d.*

Bulletin.

9. The Grain-shedding Character in Rice Plants and its Importance, by S. G. Bhalerao, B.Ag. (Bulletin No. 205.) Price, As. 12 or 1*s.* 3*d.*

List of Agricultural Publications in India from 1st February to 31st July 1930.

No.	Title	Author	Where published
	GENERAL AGRICULTURE		
1	*The Agricultural Journal of India*, Vol. XXV, Parts II, III and IV. Price, Rs. 1-8-0 or 2*s*. per part. Annual Subscription, Rs. 6 or 9*s*. 6*d*.	Issued under the authority of the Imperial Council of Agricultural Research.	Government of India Central Publication Branch, Calcutta.
2	*The Journal of the Mysore Agricultural and Experimental Union* (Quarterly). Rs. 3.	B. Narasinha Iyengar (Editor).	Bangalore Press, Bangalore.
3	*The Madras Agricultural Journal* (Monthly). Annual subscription, Rs. 4.	B. Viswanath and others (Editors).	The Electric Printing Works, Coimbatore.
4	*Poona Agricultural College Magazine* (Quarterly). Annual subscription, Rs. 2-8-0.	V. G. Deshpande and S. M. Rao (Editors).	Aryabhushan Press, Poona City.
5	*The Nagpur Agricultural College Magazine* (Quarterly). Annual subscription, Rs. 3.	S. M. Ali and N. B. Chinchalkar (Editors).	Udyam Desha Sevak Press, Nagpur.
6	*The Allahabad Farmer* (Quarterly). Annual subscription Rs. 2.	W. B. Hayes (Editor) .	The Mission Press, Allahabad.
7	*Quarterly Journal of the Indian Tea Association*. Price, As. 6 per copy.	Scientific Department of the Indian Tea Association, Calcutta.	Catholic Orphan Press, Calcutta.
8	*The Planters' Chronicle* (Weekly). Price, As. 8 per copy.	F. E. James (Editor) .	Diocesan Press, Post Box 455, Madras.
9	*Rural India* (Monthly). Annual subscription, Rs. 3.	A. Swaminatha Iyer (Editor).	Magazine Press, Chingleput, South India.
10	*Journal of the Trichinopoly District Agricultural Association* (Quarterly). Annual subscription, Rs. 1-8-0 for non-members; free for members.	Issued by the Trichinopoly District Agricultural Association.	District Agricultural Association, Trichinopoly, South India.
11	Villagers' Calendar for 1930-31 (Tamil, Telugu and Kanarese).	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
12	Broad Hints for Everyday Use (English). Madras Department of Agriculture Leaflet No. 64.	G. R. Hilson . . .	Ditto.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
13	Results of Experiments conducted at the Agricultural Research Station, Palur. (English.) Madras Department of Agriculture Pamphlet No. 2.	Rao Bahadur D. Ananda Rao and A. Ramaswami Ayyar.	Government Press, Madras.
14	Report on the Operations of the Department of Agriculture, Punjab, for the year ending 30th June, 1929, Part I. Price, Rs. 1-6-0.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
15	Seasonal Notes for April 1930. Price, As. 4.	Ditto . .	Ditto.
16	Sugarcane crushing. Punjab Department of Agriculture Leaflet No. 76.	Ditto . . .	Ditto.
17	Damping of Cotton. Punjab Department of Agriculture Leaflet No. 80.	Ditto . . .	Ditto.
18	Report on the Administration of the Department of Agriculture, United Provinces, for the year ending June 30, 1929.	Issued by the Department of Agriculture, United Provinces.	Government Press, Allahabad.
19	Report on the Working and Administration of the United Provinces Government Gardens for the year 1928-29.	Ditto . . .	Ditto.
20	A Marathi Version of the Royal Agricultural Commission's Report (Abridged)—adapted from the Hindi Version published by the United Provinces Government.	Issued by the Department of Agriculture, Central Provinces.	Central Provinces Government Printing, Nagpur.
21	A Marathi Leaflet on Some Important points of Groundnut Cultivation.	Ditto . . .	Ditto.
22	Water-hyacinth. (Assamese). Assam Department of Agriculture Leaflet No. 1 of 1930.	Issued by the Department of Agriculture, Assam.	Government Press, Shillong.
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23	Season and Crop Report, Bihar and Orissa, 1929-30.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Printing, Bihar and Orissa, Gulzarbagh.
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27	The Production of Oranges in Spain. Pusa Bulletin No. 198. Price, As. 6 or 8*d*.	W. Robertson Brown .	Government of India Central Publication Branch, Calcutta.
28	Grape Culture in Western India. Bombay Department of Agriculture Bulletin No. 156 of 1928. Price, As. 7.	S. R. Gandhi . . .	Government Central Press, Bombay.
29	Tomato Ketchup. Punjab Department of Agriculture Leaflet No. 77.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
30	Candying of fruits. Punjab Department of Agriculture Leaflet No. 78.	Ditto . . .	Ditto.
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31	The rearing of Eri Silk Worms (English). Bengal Department of Agriculture Leaflet No. 2 of 1930.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
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32	Some Digestibility Trials on Indian Feeding Stuffs, VI, Green Fodders and their Silage. Memoirs of the Department of Agriculture in India, Chemical Series, Vol X, No. 7. Price, As. 10 or 1*s*.	P. E. Lander and Pandit Lal Chand Dharmani.	Government of India Central Publication Branch, Calcutta.
33	A Study of the Capillary Rise of Water under Field Conditions. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 9. Price, As. 5 or 6*d*.	Ashutosh Sen . . .	Ditto.
34	Silage Investigations at Bangalore. Memoirs of the Department of Agriculture in India, Chemical Series, Vol X, No. 10. Price, As. 10 or 1*s*.	T. S. Krishnan . .	Ditto.

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35	Feeding Experiments at Hosur, 1926, 1927 and 1928. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. XI, No. 3. Price, As. 7 or 9*d*.	F. J. Warth . . .	Government of India Central Publication Branch, Calcutta.
36	A New Method of Estimating Total Carbonates in Soils. Pusa Bulletin No. 206. Price, As. 3 or 4*d*.	Amar Nath Puri . .	Ditto.
37	The Preparation in the Home of Infant and Invalid foods from Cholam. (English, Tamil, Telugu, Malayalam and Kanarese.) Madras Department of Agriculture Leaflet No. 61.	M. Suryanarayana . .	Government Press, Madras.
38	Home made Malt Foods from Great Millet (*Andropogon Sorghum*). (English, Tamil, Telugu, Malayalam and Kanarese.) Madras Department of Agriculture Leaflet No. 62.	Rao Bahadur B. Viswanath	Ditto.
39	Conversion of Prickly Pear into Manure. (English, Tamil, Telugu, Malayalam and Kanarese.) Madras Department of Agriculture Leaflet No. 63.	Ditto . . .	Ditto.
40	Periodicity of the Nitrate Contents of Soils. (Reprinted from *Soil Science*, Vol. XXXIX, No. 3, March, 1930.)	H. N. Batham and L. S. Nigam.	Government Press, Allahabad.
	BOTANY		
41	Studies in Inheritance in Cotton. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVII, No. 4. Price, As. 14 or 1*s*. 6*d*.	Mohammad Afzal . .	Government of India Central Publication Branch, Calcutta.
42	Root Development of Rice under Different Conditions of Growth. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 2. Price, As. 14 or 6*d*.	R. L. Sethi . . .	Ditto.
43	Studies in Gujarat Tobaccos and their Improvement. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 4. Price, As. 12 or 1*s*. 3*d*.	V. M. Majumdar . .	Ditto.

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44	Studies in Indian Oil-seeds, No. 4. The types of *Sesamum indicum*. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 5. Price, Rs. 1-8-0 or 2*s*. 6*d*.	Kashi Ram . . .	Government of India Central Publication Branch, Calcutta.
45	Classification and Study of the characters of the cultivated Rices in the United Provinces. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 6. Price, Rs. 1-10 or 2*s*. 6*d*.	R. L. Sethi and Baijanti Prosad Saxena.	Ditto.
46	List of Publications on the Botany of Indian Crops. Pusa Bulletin No. 202. Price, Rs. 3-8-0 or 6*s*.	Compiled by F. J. F. Shaw and Rakhal Das Bose.	Ditto.
	MYCOLOGY		
47	*Sorosporium Paspali* McAlp. on *Paspalum scrobiculatum* L., Kodra Smut. Pusa Bulletin No. 201. Price, As. 8 or 10*d*.	Abdus Sattar . . .	Ditto.
	BACTERIOLOGY		
48	A Method of Increasing the Manurial value of Bone Phosphate. Pusa Bulletin No. 204. Price, As. 8 or 10*d*.	N. D. Vyas . .	Ditto.
	ENTOMOLOGY		
49	A Contribution to our knowledge of South Indian Coccidæ. Pusa Bulletin No. 197. Price, Rs. 2-12 or 5*s*.	T. V. Ramakrishna Ayyar .	Ditto.
50	Red Hairy Caterpillar Pest. (English, Tamil, Telugu and Malayalam.) Madras Department of Agriculture Leaflet No. 2 (Revised).	Rao Sahib Y. Ramachandra Rao.	Government Press, Madras.
51	Hairy Caterpillar Pest on Dry Crops. (English, Tamil and Telugu.) Madras Department of Agriculture Pamphlet.	Issued by the Department of Agriculture, Madras.	Ditto.
52	Rice Hispa. (Bengalee.) Bengal Department of Agriculture Leaflet No. 1 of 1930.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.

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	ANIMAL HUSBANDRY AND DAIRYING		
53	*The Journal of the Central Bureau of Animal Husbandry and Dairy in India*, Vol. IV, Parts I and II. Price, As. 10 per part. Annual subscription, Rs. 2-8-0.	Issued under the authority of the Imperial Council of Agricultural Research.	Government of India Central Publication Branch, Calcutta.
54	Rations of Milch Cows, Dry Cows and Calves. (English, Tamil, Telugu, Malayalam and Kanarese.) Madras Department of Agriculture Leaflet No. 60.	R. W. Littlewood . .	Government Press, Madras.
55	Breeding and Rearing of Cattle and Buffaloes. (English, Tamil and Telugu.) Madras Department of Agriculture Leaflet No. 31 (Revised).	Ditto . . .	Ditto.
56	Note on Ensilage. (English, Tamil, Telugu and Malayalam.) Madras Department of Agriculture Leaflet No. 43 (Revised).	Ditto . . .	Ditto.
57	Conditions to be fulfilled for the Grant of Government Premia for breeding Bulls maintained by Private Bodies. (English, Tamil, Telugu and Malayalam.) Madras Department of Agriculture Leaflet No. 54 (Revised).	Ditto . . .	Ditto.
58	Note on the Cultivation and Management of Grass-land at the Hosur Live-stock Station, Madras. Madras Department of Agriculture Pamphlet No. 1.	Ditto . . .	Ditto.
59	Cattle Feeds of Western India. Bombay Department of Agriculture Bulletin No. 161 of 1930. Price, As. 1.	Rao Bahadur D. L. Sahasrabuddhe.	Government Central Press, Bombay.
60	Ensilage or Silage in Bengal. (English). Bengal Department of Agriculture Leaflet No. 3 of 1930.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
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62	The Problem of Rinderpest in India. Pusa Bulletin No. 199. Price, Rs. 1-4-0 or 2*s*. 3*d*.	J. T. Edwards . . .	Government of India Central Publication Branch, Calcutta.

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64	Instructions for the use of Anthrax Vaccine. Burma Veterinary Department Leaflet No. 1 of 1930.	Issued by the Director, Veterinary Services, Burma.	Government Press, Rangoon.
65	Annual Report of the Civil Veterinary Department, Assam, 1929-30.	Issued by the Civil Veterinary Department, Assam.	Government Press, Shillong.
66	*The Indian Veterinary Journal* (The Journal of the All-India Veterinary Association). (Quarterly.) Annual subscription, Rs. 4 or 5*s*. 4*d*. for members and students; Rs. 8 or 10*s*. 8*d*. for others.	P. Srinivasa Rao, G.M.V.C. (Editor).	People's Printing and Publishing House, Ltd. Triplicane, Madras.

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Plate XXVIII, facing p. 417 — insert as foot-note —.

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Page IX, line 20, *read* ' Husain ' *for* ' Hussain.'
 ,, 523 line 17, *read* " Roberts' ' *for* ' Roberts.'
 ,, 524, line 6, *delete* ' comma ' *after* ' 1919.'
 ,, 544, line 12, *read* ' barely ' *for* ' barley.'
 ,, 567, third column, last line, *read* ' Majmudar ' *for* ' Majumdar.'

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